University of Cambridge
School of Agriculture Memoirs

Memoir Nos. 15-17

A list of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Institutes during the period Oct. 1st, 1942—Sept. 30th, 1945.

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FOREWORD

This Memoir, which is published under the general editorship of the Librarian of the School, represents an attempt to present as succinctly as possible the contributions made by members of the Staffs of the School of Agriculture and its Associated Institutes to the development and progress of Agricultural Science, to indicate to research workers interested the Journals in which the full papers are presented and to act as a complete record of papers published. Each summary is compiled by the author of the paper and is presented, so far as the subject matter will allow, in a non-technical form in order to be of value to the general body of farmers interested in the more recent developments of agricultural scientific research in general and of the activities of this Department in particular.

Requests for further information or criticism arising out of the summaries should be referred to the individual author concerned, criticisms and suggestions for the improvement of the Memoir itself should be addressed to the Librarian of the School.

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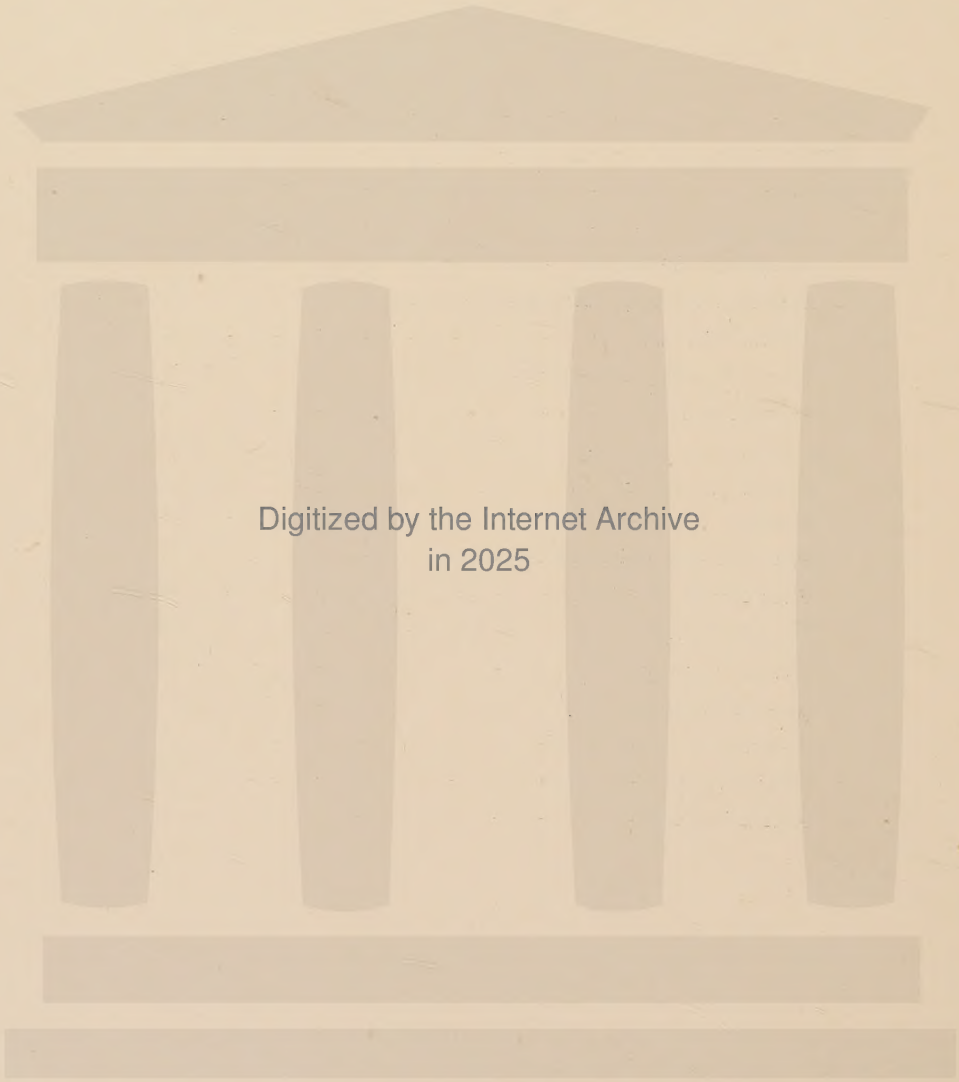

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Agricultural Education in Cambridge dates from 1892 *when the Cambridge and Counties Agricultural Education Committee, an informal body consisting of University Professors and County Council representatives, first organized an Agricultural Course. In* 1899 *the University created a Department of Agriculture to take over the work of this Committee. The School of Agriculture was built by public subscription in* 1909 *and expanded by a grant from the Development Commission in* 1912. *The rapid expansion of the Animal Nutrition Institute and the Plant Breeding Institute under the direction of Professor T. B. Wood and Professor R. H. Biffen led to increased demands on accommodation, and an extension to the building was made in* 1925–26 *by the aid of a further grant from the Development Commission. The Estate Management Branch was established to provide technical and professional assistance in the management of University and College property and with a view to affording opportunities for practical demonstrations in connection with the teaching of Estate Management subjects.*

The Rockefeller Benefaction, made to the University in 1929, *provided money for additional accommodation for the Department of Agriculture and for an expansion of its activities, and a new building was completed and occupied in March,* 1933.

The Department of Agriculture is a teaching department of the University and offers a course of instruction leading to a degree and separate courses leading to graduate diplomas in Agriculture and Agricultural Science. Research in the problems of agriculture and cognate sciences is carried out by members of the teaching staff and by members of the staffs of the Research Institutes attached to the Department. There are also a number of advisory officers who are available to give assistance and advice to farmers on their problems. Additional facilities for both teaching and research are provided by the University Farm which occupies an area of some 700 *acres within reasonable distance of the scientific laboratories.*

** Limited reprints available for free distribution. Please quote marginal number instead of full title. Enquiries for papers not starred should be sent to the author.*

AGRICULTURE

ENGLEDOW, F. L.
West Indian Royal Commission on Agriculture, Fisheries, Forestry and Veterinary Matters.
Pp. viii + 235. Cmd 6608. H.M.S.O., London, 1945. Price 3*s.* 6*d.*

FYFE, J. L. & BARSON, D. M.
England—Root Crops and Vegetables. Pp. 7–23.
Contribution to *The Production of Seed of Root Crops and Vegetables.* Imp. Agric. Bur. Jt. Publ. No. 5, 1943. Pp. 95. Price 3*s.*
The contribution on English root and vegetable seed growing deals with supplies, the structure of the seed industry, legislation, general technique, varieties, zoning and the method of cultivation of the different seed crops.

GARNER, F. H.
The Cattle of Britain.
Pp. 158. Longmans, 1944. Price 18*s.*

GARNER, F. H.
The Farmer's Animals.
Pp. 99. Camb. Univ. Press, 1943. Price 4*s.* 6*d.*

MANSFIELD, W. S. *et al.*
Cattle at the Cross-Roads.
Pp. 60. Littlebury, 1944. Price 5*s.*

MANSFIELD, W. S.
Farming Talks.
Pp. 120. Littlebury, 1944. Price 7*s.* 6*d.*

809* WESTON, W. A. R. D. & GARNER, F. H.
Winter Beans in East Suffolk
Agriculture : J. Minist. Agric. 1943, **50,** 268–271.
A discussion of the factors responsible for bean failures. Frost injury occurs in most years, but it is only occasionally severe ; ploughing-in beans in early October, or drilling in late October is recommended. Frost injury in spring is frequently followed by Chocolate Spot (*Botrytis cinerea*), which has two phases, "aggressive" and " non-aggressive " ; conditions favourable to the disease are mentioned. Practical advice is given for improving bean crops, reference being made to time and depth of planting, seed disinfection, drainage, hoeing and manuring. Bean Rot (*Sclerotinia Trifoliorum*) is described, and other leguminous crops susceptible to it are mentioned.

OTHER PAPERS

CHILDS, E. C. **What Should be the Length of a Mole Plough Beam ?** *Fm Impl. Mach. Rev.* 1943, **68,** 895-896.

ENGLEDOW, F. L. **Science and the Land.** *Chem. & Ind.* 1942, **61,** 239–245.

GARNER, F. H. **Experiences in Land Reclamation : East Suffolk.** *J. R. Agric. Soc.* 1942, **103,** 113–117.

GARNER, F. H. **Recent Developments in Silage Making.** *J. R. Agric. Soc.* 1942, **103,** 161–166.

HANLEY, F. **Lodging in Cereals.** *Agriculture : J. Minist. Agric.* 1941, **48,** 212–216.

HANLEY, F. **Ploughing Grass without Reducing Live Stock.** *Agriculture : J. Minist. Agric.* 1940, **47,** 143–148.

HUNTER, H. **Malting Barley and How to Grow It.** *Brew. J.* 1945, **79,** 245–246.

HUNTER, H. **The Production of Barley.** *Agriculture : J. Minist. Agric.* 1940, **47,** 200–201.

MANSFIELD, W. S. **Lucerne and Sainfoin.** *Agriculture : J. Minist. Agric.* 1945, **52,** 255–258.

MANSFIELD, W. S. **The Maintenance of Land Fertility in War Time.** *J. Fmrs' Club.* Pt. I. September, 1941.

MANSFIELD, W. S. **Short Fallows.** *Agriculture : J. Minist. Agric.* 1943, **50,** 175–178.

AGRICULTURAL ECONOMICS

Changes in the Economic Organization of Agriculture. A Comparative Study of Conditions in the Eastern Counties of England between an Identical Sample of Farms in 1938-39 to 1942-43. *Fm Econ. Br. Rep. No.* 29, 1945. Pp. 108. Price 7*s.* 6*d.*
This report examines the financial and quantitative changes which occurred in four districts in the Eastern Counties during the years 1938 to 1943, and is similar in arrangement to previous publications in this Series.
Between 1938 and 1943, on a sample of 200 farms, gross incomes and gross charges rose by roughly 50% and 40% respectively, while profits increased from about £1 to £5 per acre. Changes were more pronounced in certain districts than in others and the very considerable annual shifts which occurred between districts in the composition of farm transactions are shown in tabular form.

Harvesting by Combine and Harvester.
Fm Econ. Br. Fmrs' Bull. No. 9, 1944. Pp. 12. Price 2*s*.

MENZIES-KITCHIN, A. W.
The Future of British Farming.
Pp. 64. Pilot Press, 1945. Price 5*s*.

PETTIT, G. H. N.
Wartime Changes in Milk Production.
Fm Econ. Br. Fmrs' Bull. No. 8, 1942 (Out of Print)
Members of the Cambridge Food Recording Scheme for Dairy Cows, who are representative of the larger and more progressive herds of the Eastern Counties, sustained a decline in average milk yield per cow from 711 gallons in 1938–39 to 643 gallons in 1940–41. This was due, almost wholly, to a decline in the quantity and quality of foods. During the same period annual charges per cow rose from £31 10*s*. to £44, three-quarters of the increase being due to higher unit charges for foods.

STURROCK, F. G.
Costs of Grain Harvesting.
Winchester Conference on *Modern Grain Harvesting* pp. 65–71. 1944.
Details of an investigation into the costs of harvesting by combine and by binder during 1943 in Cambridgeshire and the adjoining counties.
In the case of crops cut by combine, there was a saving of 23/4*d*. per acre when the straw was stacked and 34/4*d*. per acre when it was burned. The use of a combine also resulted in a substantial economy in manual labour. There was little difference in the cost of crops cut by combine and those cut by binder and threshed straight from the field. Here again however, the combine showed a substantial saving in manual labour. There was no marked difference between small and large combines in the cost per acre of crop harvested.

706* YATES, F., BOYD, D. A. & PETTIT, G. H. N.
Influence of Changes in Level of Feeding on Milk Production.
J. Agric. Sci. 1942, **32**, 428–456.
Analysis of all available experiments upon varying levels of feeding indicates a milk-production ration of about 2·8 lb. starch equivalent per gallon for greatest efficiency, having regard to the high overhead and maintenance requirements of the cow. This is approximately the most profitable rate of feeding at 1941–42 prices.
In general, substitution of bulky foods for concentrated foods does not reduce milk yield unless it leads to lowered total nutrient intake.

Farm Economics Branch War Series Reports †

No. 13. A Survey of the Cost of Producing Potatoes in Three Districts in the Eastern Counties. (Out of print).
No. 14. A Survey of the Cost of Producing Sugar Beet in Three Districts in the Eastern Counties. (Out of print).
No. 15. A Survey of the Cost of Producing Brussels Sprouts in the Biggleswade District of Bedfordshire. (Out of print).
No. 16. A Survey of Savoy Cabbage Growing in Essex. (Out of print).
No. 17. A Survey of the Production of Spring Cabbage and Spring Greens in Essex. (Out of print).
No. 18. A Survey of Broccoli Growing in the Holland Division of Lincolnshire in 1942/43. (Out of print).
No. 19. A Survey of Flax Growing in the Eastern Counties of England in 1942.
No. 20. An Investigation into the Cost of Producing Green Peas in Essex in 1943.
No. 21. An Investigation into the Cost of Producing Runner Beans in Bedfordshire and Essex in 1943.
No. 22. An Investigation into the Cost of Growing Field Beans in Suffolk and Essex in 1943.
No. 23. An Investigation into the Cost of Growing Mangolds and Marrow Stem Kale in Norfolk and Hertfordshire in 1943.
No. 24. An Investigation into the Cost of Growing Onions in Bedfordshire and Lincolnshire in 1943.
No. 25. An Investigation into the Cost of Growing Carrots in Norfolk, Huntingdonshire and the Isle of Ely in 1943.
No. 26. Grazing Charges, 1942–43, and Milk Production, with a Note upon Direct Re-seeding. A Study of Conditions in the Eastern Counties of England.
No. 27. An Investigation into the Cost of Growing Brussels Sprouts in Bedfordshire in 1943/44.
No. 28. An Investigation into the Cost of Growing Savoy Cabbage in Essex and the Holland Division of Lincoln in 1943/44.
No. 29. An Investigation into the Cost of Growing Spring Cabbage in Essex and the Holland Division of Lincoln in 1943/44.
No. 30. Further Wartime Changes in Milk Production. A Preliminary Report upon the Cambridge Food Recording Scheme for Dairy Cows for the Years 1940–41, 1941–42 and 1942–43.

† Nos. 1–12 are not available. Others, unless marked out-of-print, may be obtained from the Farm Economics Branch.

813* Cockbill, G. F., Henderson, V. E., Ross, D. M., & Stapley, J. H.
Wireworm Populations in Relation to Crop Production.
Ann. Appl. Biol. 1945, **32**, 148–163.

The wireworm survey in the Eastern Counties revealed many cases where the observed wireworm damage failed to correspond with the estimated field population. A possible explanation for this was the inaccuracy of counts made by picking wireworms out of the soil samples by hand. Tests showed that such methods recovered an extremely variable proportion of the wireworms in the samples and, on the average, only two-fifths of the larvae were obtained. A modified form of the washing and flotation technique used by Salt & Hollick (1944) was introduced for the large-scale work and is descibed. By this method, ten samples of soil (4 ins. diam. and 6 ins. deep) bulked together are examined at a time and can be dealt with at the rate of 13 samples per man per hour with an efficiency of 95-100% in the extraction of wireworms. The populations estimated on 600 fields sampled between December 1942 and May 1943 have thrown more light on the size and composition of the wireworm population in grass and arable fields. Inspection of the crop results on fields tested by the washing process showed a much closer relationship between wireworm population and wireworm damage than had been obtained by the hand-sorting method in the previous year.

711* Howard, H. W.
The Genetics of *Armadillidium vulgare* Latr. II. Studies on the Inheritance of Monogeny and Amphogeny.
J. Genet. 1942, **44**, 143–59.

In this woodlouse thelygeny (the production of broods consisting of females only) appears to be inherited cytoplasmically or on the Y chromosome (assuming the female to be the heterogametic sex).

718* Howard, H. W.
Length of Life of Sperms in the Woodlouse *Armadillidium vulgare* Latr.
Nature, Lond. 1943, **152**, 331.

Sperms are still viable after one year in impregnated females of this woodlouse.

Morley, D. B. W.
Ant Butter.
Nature, Lond. 1945, **155**, 517.

The records of the occurrence of " ant butter " or " ant amber " in the nests of the woodland species of *Formica* are collated and briefly discussed.

Morley, D. B. W.
Classification of Ants.
Nature, Lond. 1944, **153**, 321–2.

It is pointed out that nomenclature " is but an artifice "—a mechanism for handling the data appertaining to biology as simply as possible—and that as such the taxonomy of a group should be well ordered, comprehensible and easily accessible. The importance of Donisthorpe's ' List of the Type Species of the Genera and Sub-genera of the Formicidae ' (*Ann. Mag. Nat. Hist. ii*, 1943, **10**, 617, 649, 721) is discussed.

Morley, D. B. W.
An Important Step Forward in Formicid Nomenclature.
Ent. Rec. 1944, **56**, 63–64.

A detailed critical review of Donisthorpe's ' List of the Type Species of the Genera and Sub-genera of the Formicidae ' (*Ann. Mag. Nat. Hist. ii*, 1943, **10**, 617, 649, 721).

Morley, D. B. W.
Observations on Some Plesiobiotic Colonies of Ants (*Hymenoptera*) with Notes on Some Other Mixtobiotic Colonies.
Proc. R. Ent. Soc. Lond. 'A'. 1945, **20**, 1–4.

Observations made on plesiobiotic colonies of ants at Porlock are recorded. The terms proposed by Wheeler (1910) for various forms of consociations of different species of ants are listed and discussed, and a new term, *mixtobiosis*, is proposed to include " all types of mixed and compound nests of ants (and ants and termites)".

Observations concerning the mixed colony of *Acanthomyops* (*Dendrolasius*) *fuliginosus*, Latr. and *Acanthomyops* (*Chtonolasius*) *mixtus*, Nyl. at Bournemouth are discussed and a new hypothesis for the method of colony foundation of *A. fuliginosus* is put forward.

A case of phylacobiosis, observed by Dr. Julian S. Huxley in West Africa and communicated to the author, is recorded.

780* Morley, D. B. W.

A Study of the Ant Fauna of a Garden, 1934-42.

J. Anim. Ecol. 1944, **13,** 123–127.

The ants nests of a 2½ acre garden at Bournemouth and the territory of the various colonies have been carefully mapped over a period of 8 years, and summarized in three maps covering the years 1934-7 ; 1938-40 ; 1940-2.

The success of the various species of ants, measured in terms of the area they foraged over and dominated, varied greatly throughout the period. These variations are indicated and discussed.

A remarkable change of habit of *Acanthomyops* (*Chtonolasius*) *mixtus*, Nyl. when living in association with *Acanthomyops* (*Dendrolasius*) *fuliginosus*, Latr. is recorded, and details of the behaviour of the other species of ants in the garden are given.

779* Morley, D. B. W. & Donisthorpe, H. St. J. K.

A List of the Scientific Terms used in Myrmecology.

Proc. R. Ent. Soc. Lond. 'A'. 1945, **20,** 43–9.

The specialized scientific terms used and invented by different myrmecologists are listed and each one is defined, the original author being cited.

788* Petherbridge, F. R. & Jones, F. G. W.

Beet Eelworm (*Heterodera schachtii* Schm.) **in East Anglia 1934-1943.**

Ann. Appl. Biol. 1944, **31,** 320–332.

Observations made on the beet eelworm (*Heterodera schachtii* Schm.) between 1934 and 1943 are described. This eelworm confines its attacks to crop plants of the families Chenopodiaceae and Cruciferae. Cysts similar to those of the beet eelworm have been recorded on many weeds. Records of beet eelworm on weeds of the above families are probably authentic, but those of other families require confirmation. In the field, the four so-called strains of *Heterodera schachtii*, viz., the beet, oat, pea and potato strains, behave as distinct species. Some evidence is given for the possible existence of a cruciferous strain.

Attempts were made to ascertain the distribution of beet eelworm in East Anglia. A general search was conducted throughout the area and special attention paid to beet-sugar factories, beet-loading sites, sewage farms, and to certain important beet-growing areas located in the Isle of Ely and neighbouring counties. Throughout the search, diagnosis was based on the finding of lemon-shaped cysts on the roots of sugar beet, red beet or mangolds. Details of our present knowledge of the distribution of beet eelworm are given. It appears to have been present in Britain for a considerable time but is not yet widely disseminated.

The spread of beet eelworm is considered in detail, and it is concluded that the establishment of the beet-sugar industry has led to a considerable increase in the rate of spread.

Measures for the control of beet eelworm are described. In the early days of the industry, beet was grown without regard to rotation, thus providing conditions similar to those existing in Germany before 1870 when ' beet-sickness ' was becoming a serious problem. The first control measure was the introduction of a clause into contracts forbidding the growing of beet after beet or mangolds. More effective measures, which were adopted in 1939, are described. In 1943, the Sugar-Beet Eelworm Order was issued enforcing these measures over a wide area and extending them to cover all susceptible crops.

Effective control measures may result in a reduced rate of spread of the beet eelworm but cannot eliminate it.

790* Petherbridge, F. R. & Stapley, J. H.

Two Important Wheat Pests.

Agriculture : J. Minist. Agric. 1944, **51,** 320–324.

An account is given of observations on wheat bulb fly and wheat shoot beetle (*Helophorus nubilus*). Wheat bulb fly damage to wheat shows up in March and usually follows a previous fallow. In certain fen districts much damage was recorded after sugar beet and potatoes, in which crops, evidently, the fly lays eggs. It was found that the greatest loss occurred to wheat sown after mid-October, earlier sowings being able to withstand attacks.

Wheat shoot beetle damage to wheat occurs after leys and particularly after ryegrass and clover, but damage also occurs after sainfoin or trefoil. Except occasionally after cereals, wheat after other crops does not appear to be attacked. No serious damage by wheat shoot beetle has been recorded in leys broken up in August. In all cases recorded, the leys had been broken up in September and October. Date of sowing has an influence on the damage sustained. Wheat sown in early October has tillered and formed secondary roots before the main attack begins. Damage usually occurs on soils of light or light to medium texture, such as the light Norfolk soils or the light soils in the east Cambridgeshire area. No investigation has yet been made on heavy soils.

Petherbridge, F. R., Wright, D. W. & Davies, P. G.

Investigations on the Biology and Control of the Carrot Fly (*Psila rosae F.*)

Ann. Appl. Biol. 1942, **29,** 380–392.

Observations were made on the emergence and abundance in the field of adults of the first and second generations of carrot fly. Experiments to control the first generation on early carrots by derris dust were not successful. Large numbers of second generation flies were killed by spraying the dike-sides and headlands with a poison bait : this reduced the crop damage in the treated fields. Some control in small scale experiments was obtained by placing grass cuttings with and without 4% calomel dust along the rows. The adults of both

generations were found in greatest numbers on the headlands and dike-sides of carrot fields. Eggs were most common on the headlands of carrot fields. Observations were also made on the position and numbers of eggs in the soil and their occurrence in late autumn. Few larvae appear to leave the carrots to pupate until late winter and early spring. Carrots sown at weekly intervals from April until late June were attacked to a similar extent : on carrots sown after this date the attack progressively decreased. No decrease in infestation resulted from sowing onions with carrots. Deterioration through maggot attack in unlifted carrots was most rapid in October and November. In clamps, deterioration was less rapid and extensive than in unlifted carrots. The flies feed on the flowers of wild chervil and hemlock : hemlock is also a host for the larvae of both generations. A survey of carrot fields in Norfolk in 1941 showed that flies of the first generation were scarce. The attack which followed was very slight. In west Suffolk the number of flies present and the damage recorded later were much greater.

PETHERBRIDGE, F. R. & WRIGHT, D. W.

Further Investigations on the Biology and Control of the Carrot Fly (*Psila rosae F.*)
Ann. Appl. Biol. 1943, **30**, 348–358.

Records were obtained for the emergence of the first and second generation flies at Chatteris and Cambridge. There is a correlation between the age of the carrot crop and the commencement of the emergence of the second generation from it. The first generation was successfully controlled by killing the flies with a poison bait sprayed on the dike-sides of the carrot fields. This treatment reduced the population of second generation flies and also their attack. Spraying dike-sides and/or the headlands of eight maincrop carrot fields in August and September greatly reduced the second generation damage. Very high kills of carrot fly were obtained on the headlands of treated fields. Poor results were given by the treatment on three very weedy fields which were incompletely treated. A marked increase in attack occurred in three untreated areas in 1942 as compared with the previous year.

Application of the poison bait spray in the field is discussed. Creosote-treated string gave promising results in small-scale experiments for the control of the second generation. Calomel dust (4%) with and without grass cuttings caused no reduction in attack.

In hot sunny weather the flies shelter in the vegetation around carrot fields from about 10 a.m. until about 5 p.m. In the cooler conditions of early morning and evening there is a movement of flies into the field. This rhythm is not maintained in dull warm weather.

Seedling carrots may be attacked in the field any time after the cotyledon stage. This enables the first generation of flies to propagate on main crop carrot. Soil sections about carrot rows showed that pupae of the overwintering generation are closely congregated around the carrots. Various insecticides were tested for the destruction of pupae in the soil A creosote-sawdust mixture gave the best results.

Storage experiments showed that clamped carrots deteriorate much less than those unlifted. The population of flies is greatly increased by allowing attacked carrots to remain unlifted throughout the winter or by ploughing-in.

797*WRIGHT, D. W.

Mercury as a Control for Stored Grain Pests.
Bull. Ent. Res. 1944, **35**, 143–160.

The Indian custom of placing metallic mercury with the grain in the storage container to prevent infestation by insects has been investigated. It is found to have a sound scientific basis as the presence of mercury prevents the reproduction of certain pests.

Experiments showed that the vapour of mercury was fully effective in preventing reproduction of the grain weevil (*Calandra granaria*), the saw-toothed grain beetle (*Oryzaephilus surinamensis*), the lesser grain borer (*Rhizopertha dominica*), and the Angoumois grain moth (*Sitotroga cerealella*).

Zinc and tin amalgams and calomel were less effective than metallic mercury.

The efficiency of a given weight of mercury is increased by subdivision, a process which increases its total surface area.

Mercury in a finely divided form, incorporated in a solid porous base, was found to be highly effective.

Those mercurials which proved effective were found to emit a vapour which contained free mercury.

Storage in mercury vapour was found to have no effect on the vitality of adult grain weevils, neither did it affect their subsequent reproductive capacity.

The eggs of the grain weevil and those of the Angoumois grain moth were found to be very susceptible to mercury vapour and failed to hatch in its presence.

Germination and spectroscopic tests on grain stored for several months with mercury gave no indication that contamination had resulted. The grain weevil was able to breed vigorously in grain which had been so treated.

796*WRIGHT, D. W., PETHERBRIDGE, F. R. & ASHBY, D. G.

The Biology and Control of the Carrot Fly.
Agriculture : J. Minist. Agric. 1944, **51**, 11–15.

An account is given of the life history and damage caused by this pest. The value of cultural measures of control are discussed and shown to be of considerable value in preventing damage. These include adequate spacing of carrots in the rotation, segregation of early and late crops and the lifting and clamping or disposal of the latter in October or November.

For heavily infested areas a method of control using a poison bait containing sodium fluoride and molasses is described. Clamping in autumn is shown to prevent further damage of the roots which will be considerable if the crop is left in during the winter. A treatment for destroying the pupae on clamp sites is outlined.

OTHER PAPERS

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MORLEY, D. B. W. **Economic Ants.** *Discovery.* 1943, **4,** 351–2.

744* PETHERBRIDGE, F. R. & WESTON, W. A. R. D. **Flea Beetles.** *Agriculture : J. Minist. Agric.* 1945, **52,** 37–39.

815* PETHERBRIDGE, F. R. & WESTON, W. A. R. D. **Potato Root Eelworm.** *Agriculture : J. Minist. Agric.* 1945, **52,** 264–265.

PETHERBRIDGE, F. R., WRIGHT, D. W. & ASHBY, D. G. **The Biology and Control of the Carrot Fly.** *Ann. Appl. Biol.* 1945, **32,** 262–268.

ANIMAL BEHAVIOUR

719* MORLEY, D. B. W.

Observations on the Nest Odour of Ants.

Proc. Linn. Soc. Lond. Session 154, 1941-2, 109–114.

Ants recognise friend or foe primarily by means of the olfactory sensillae situated in the antennae. Not only are they able to differentiate between ants belonging to different species, but also those belonging to different colonies of the same species. Actual antennal contact is not necessary before recognition is effected.

The significance of the artificially produced multiple mixed colonies of different species of ants previously developed by the author (*Proc. R. Ent. Soc. Lond.* 'A'. 1940, **15,** 103–104), and later hitherto unpublished experiments using a similar technique, is discussed. The theories of Forel and Fielde are rejected as unnecessarily complex.

It is suggested as more probable that there is a basic species odour, probably produced by a glandular secretion which may be expressed onto the cuticle, and that the individuality of the species odour is imparted by slight deviations from the true species odour brought about by the ants licking one another, by their encounters with other ants and myrmecophiles, by their food and the materials of which the nest is made and other extrinsic factors.

WALTON, A.

Comparative Sexual Behaviour of the Male.

Proc. Roy. Soc. Med. 1944, **37,** 660–661.

The pattern of sexual behaviour is in large measure determined by the anatomical structures of the male and female organs. Sexual reflexes are more limited in number than one might suppose from the complexity of the mating pattern, but this complexity is due to the extent to which the reflexes become conditioned by environmental stimuli acting through the various sense organs.

As a result of the experience gained at centres for artificial insemination much has been learned of the extent to which basic reflexes can be conditioned by environmental stimuli. After a period of continuous use many bulls show a decline of sexual potency and fertility. In many cases this change may be traced to the gradual reinforcement of conditional inhibitions associated with slight deviations from the normal technique of collections.

OTHER PAPERS

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ANIMAL BREEDING AND GENETICS

CHANG, M. C.

Sperm Production of a Pony Stallion and the Treatment of the Spermatozoa *in vitro* with Special Reference to Artificial Insemination of Mares.

J. Agric. Sci. 1943, **33,** 67–73.

The sperm production of a pony stallion kept a constant high level when the collection of sperms was performed regularly three times a week. There was no adverse effect on the stallion or on the quantity and quality of the sperms. There is a negative correlation between the volume of semen and the concentration. The total number ejaculated remains relatively constant ; the volume of accessory fluids is more variable.

The motility of horse spermatozoa after dilution with eight different kinds of chemical media and stored at different temperatures was studied : Glucose-yolk-phosphate dilutor devised by Lambert & McKenzie and glucose-yolk-tartrate dilutor devised by the author were found to be the best for the preservation of horse sperms at low temperature. There was not much difference between those diluted samples stored for 24 hr. at 10°C. and those slowly cooled to 1°C. Concentration of the semen by centrifuge is definitely beneficial for the preservation of horse sperms.

Pregnancies were obtained by the insemination of sperms centrifuged and kept at 1°C. for 24 hr. The sperms of one stallion can be used for a great number of mares if artificial insemination is practised. The adoption of new techniques for the determination of the time of ovulation and for the induction of ovulation is suggested for successful artificial insemination of mares.

HAMMOND, J. Jun.

Advances in Goat Breeding.

Brit. Goat Soc. Yearb. 1943, 45–46.

Goats in anoestrum during the summer can be caused to come on heat by the injection of 600–2000 i.u. of pregnant mare serum. Many of them after mating produce kids in the Autumn from September to November and add to the supply of winter milk. Artificial insemination in goats is also suggested as a method of overcoming many of the present difficulties connected with breeding goats.

HAMMOND, J. Jun.

Observations on the Breeding Season in Sheep and its Artificial Extension.

Rep. Proc. Brit. Soc. Anim. Prod. 1944, **2**, 55–57.

Observations on the breeding season of Suffolk × Border Leicester Cheviot ewes backcross to a Suffolk ram showed that the breeding season extends from the end of August to early April. Twinning percentage was highest for service at the end of October and declined steadily thereafter. The effect of treatment with pregnant mare serum during the non-breeding season is described.

774* HAMMOND, J. Jun.

On the Breeding Season in the Sheep.

J. Agric. Sci. 1944, **34**, 97–105.

Ewes. There was some variation from year to year in the times of onset and end of the breeding season ; on the average it was evenly spaced on either side of the shortest day. Occasionally ewes were served and became pregnant at times well outside the normal limits of the breeding season. Lambs were allowed to suckle the ewes for as long as they would ; when lambing occurred more than about 100 days from the start of the season there was no delay in onset of heat in the ewe. When lambing was later there was some delay, but the duration of the lactation anoestrum shortened to a minimum near the middle of the season and then lengthened again.

In the first half of the season the period of the oestrous cycle lengthened slowly and steadily ; in the second part it became more variable, there was first a slight shortening, but upon the whole it continued to increase in length. From the start of the season the frequency of twinning increased quickly to a peak in about November and then declined for the rest of the season. At the end of the season there was a high proportion of services not fertile.

Lambs. Growth in the first 2 months was greatest in those born in May ; in the fourth to sixth months it was greatest in the earliest born and least in the latest, the highest weight at 6 months old being reached by those earliest born.

In lambs about 300 days old the breeding season began at the same time as in mature ewes. In those younger the season began later, the age at the first heat decreasing to a minimum of about 180 days when the heat came in the middle of the season ; in lambs later born heat was delayed until the next season.

From the breeding organs of lambs collected at the slaughterhouse ovulatory activity seemed to be evenly spaced either side of the shortest day. Quite large follicles were regularly noted throughout the anoestrous period. In a proportion isolated ovulations (not recurring repeatedly) were found to occur. At all times the ovulation rate was higher in those which had not recently had an active corpus luteum. In those having regular cycles the rate was higher at the beginning than at the end of the season ; this paralleling the incidence of twinning found in the ewes. At all times in the season the ovulation rate was much above the incidence of twinning found in ewe-lamb flocks.

Since it seems to be less the absolute amount than the change in extent of exposure to light which governs the onset of reproductive activity, it would not be expected that the season should extend as long after the shortest day as before. An action of luteal tissue in facilitating the recurrence of ovulation might have this effect, this seems to be demonstrated by the tendency to spontaneous ovulation following hormone treatment in anoestrum (see Hammond *et al.* 1942, *J. Agric. Sci.* **32**, 308 ; also unpublished work). Some of the observations here recorded also suggest such an action.

772* KYAW, M. H.

Rapid Method of Standardization of the Density of Bull Semen.

J. Agric. Sci. 1944, **34**, 106–109.

An accurate method of estimating the density of spermatozoa in a suspension by the haemocytometer is described.

A rapid method of estimating the density of a semen sample by the use of Brown's opacity tubes is given. There is a simple linear relation between opacity and density, the latter expressed in terms of millions of spermatozoa per ml. being approximately five times the opacity standard.

The rapid method is sufficiently accurate for use in insemination centres.

757* LAING, J. A.

Observations on the Characteristics of the Semen in Relation to Fertility in the Bull.

J. Agric. Sci. 1945, **35**, 1–24.

The characters of the semen of twenty-one bulls were compared with their fertility as expressed by the service rate—the number of services required for each conception.

It was found that, on the basis of the density of the semen, the total number of spermatozoa ejaculated, the motility and change in *p*H of the semen on incubation at 37°C., the animals could be divided into a higher fertility group with service rates from slightly more than 1·0 to about 3·5, and a lower fertility group with service rates from above 3·5 to ∞. Totally sterile animals could be detected.

It is suggested that factors other than the quality of the semen can vary fertility so as to give service rates at different levels from 1·0 to about 3·5. Below a certain level of semen quality fertility appears to be impaired no matter what other factors operate.

No relationship could be detected between the percentage of abnormal spermatozoa ejaculated and the service rate.

Standards for use in diagnosis of fertility are suggested.

PEASE, M. S.

Other Sorts of Auto-Sexing Poultry.

Autosexing Annu. 1945, **1**, 7–9.

It is shown that the sex-linked Silver gene can be used in the same way as the Barring gene to make a pure breed of poultry which shows a sex-distinction in the downs at hatching.

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751* HAMMOND, J. **Breeding for Fancy and Breeding for Utility.** *Squills.* 1945, 14–16.

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805* HAMMOND, J. **The Breeding of Cattle for Milk.** *Agric. Progr.* 1944, **19**, 23–24.

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804* HAMMOND, J. **Scientific Aspects of Breeding Dairy Cattle.** *Agriculture: J. Minist. Agric.* 1944, **50**, 489–492.

777* HAMMOND, J. JUN. **Control of Ovulation in Farm Animals.** *Nature, Lond.* 1944. **153**, 702.

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ANIMAL NUTRITION

ASHTON, T.

The War-time Feeding of Concentrated Food to Pregnant Rabbits.

Emp. J. Exp. Agric. 1944, **12**, 51–53.

Under war-time conditions the feeding of concentrates to does during pregnancy is shown to be unimportant, adequate food during suckling and arbitrary limitation of litter size are more important, as judged by the weight of the litter at killing age.

784* Halnan, E. T.

Animals as Food Converters.

Proc. Nutrit. Soc. 1944, **1**, 32–36.

In this paper the relative efficiencies of farm animals for the conversion of feeding stuff protein and energy to food protein and energy are considered. For the most efficient use of animal feeding stuffs, the figures obtained support the view that the livestock policy of a beleaguered country should be based on the production of milk, with veal as a bye-product, on egg production with *petit poussin* meat as a bye-product, and with lamb production limited to hill grazings.

Halnan, E. T.

Digestibility Trials with Poultry. IX.

The Digestibility and Metabolizable Energy of Sunflower Seeds.

J. Agric. Sci. 1943, **33**, 113–115.

Sunflower seeds proved useful as a partial cereal grain substitute for egg production, and eggs produced on rations containing sunflower seeds proved excellent both in flavour and in quality. Digestibility trials yielded the following figures :—

	Average percentage composition of Hungarian sunflower seeds.	Percentage digestibility.
Moisture	6·73	—
Protein	18·00	84·4
N-free extract	19·27	17·0
Ether extract	26·41	94·3
Fibre	25·88	3·9
Ash	3.71	—

Gross energy 5·468 kg.cal./g.

Metabolizable energy expressed as percentage of gross energy 56·5.

The metabolizable energy yield of sunflower seeds lies between that of wheat and maize.

782* Halnan, E. T.

Digestibility Trials with Poultry. X.

The Effect of War-time Changes in Milling Practice on the Composition and Nutritive Value of Fine and Coarse Wheat Bran.

J. Agric. Sci. 1944, **34**, 133–138.

Digestibility tests with poultry, and one with rabbits, on brans produced under war-time conditions led to the following conclusions :—

1. Changes in war-time milling practice, brought about by the implementation of Government policy directed towards maximum production of flour for human use, at first led to the production of a fine bran, somewhat better in food value than pre-war bran, and a coarse bran, of poorer quality than pre-war bran. Later, owing to dilution of the grist with barley, the quality of the fine bran deteriorated and became worse than that of pre-war bran.

2. The changes noted were largely caused by the extremely efficient removal of the starch by the millers, and reflect the ability shown by the milling industry in diverting to human food supplies the maximum possible edible food material present in the wheat berry.

3. The superior efficiency of the rabbit's digestive system for dealing with fibrous foods, as compared with the fowl's, is emphasized by the differences in the amounts of digestible nutrients extracted from a given sample of coarse bran by these two classes of animals. 1 kg. of coarse bran yielded 2522 kg. cal. of metabolizable energy in the rabbit as compared with 1637 kg. cal. in the fowl.

4. In the case of bran, the nutritive value of the N-free extract appears to be correlated with its starch content, the other soluble constituents of the N-free extract being apparently non-utilizable by the fowl.

5. The inclusion of barley by-products in wheat bran adversely affects the nutritive value of the resultant product, a fine bran derived from a pure wheat grist yielding a metabolizable energy value of 2059 kg. cal. per kg., whereas a similar product derived from a mixed wheat-barley grist yielded 1511 kg. cal. per kg.

6. The metabolizable energy derived from coarse bran by fowls is not altered by preliminary grinding of the bran to a finer particle size.

783* Halnan, E. T.

Digestibility Trials with Poultry. XI.

The Digestibility and Metabolizable Energy of Raw and Cooked Potato Flakes, Dried Potato Slices and Dried Potato Shreds.

J. Agric. Sci. 1944, **34**, 139–154.

A series of digestibility trials on fowls with a number of potato products led to the following conclusions :—

1. Raw potatoes, though readily consumed by fowls when mixed with other foods, are not readily utilized, the potato starch largely escaping digestion.

2. Boiled potatoes are readily utilized by the fowl, the preliminary cooking altering the structure of the starch grain in such a way as to render the starch readily digestible.

3. The energy derived from 1 lb. of cooked potatoes is, in the fowl, equivalent to the energy derived from no less than 5 lb. of raw potatoes.

4. The food value of dried potato products is shown to be dependent upon the nature of the heat treatment to which the potatoes are subjected in the preliminary treatment of drying.

5. Dried potato slices of the type produced in sugar-beet factory driers have a value approximating that of well-boiled potatoes, both values being compared on a dry-matter basis.

6. The crude protein of the potato is as readily available from raw potatoes as from cooked potatoes.

7. The results of these experiments strongly support the desirability of cooking potatoes intended for use in poultry feeding.

781* HALNAN, E. T.

Observations on the Value of Whale-meat as a Constituent of Chick Diets, with a Note on the Influence of Added Protein on the Efficiency of Utilization of the Gross Energy of a Ration.

J. Agric. Sci. 1942, **32**, 179–193.

A method of assessing the biological values of proteins by the slaughter method, using day-old chicks as experimental material, is outlined.

Whale-meat meal, when added to a cereal basal ration, is shown to possess a high biological value for chicks.

The method of preparation of animal protein is shown to affect its nutritive value, whale meat dried at a low temperature giving better results than that dried at a high temperature.

The nature and amount of a protein added to a cereal ration materially affects the efficiency of utilization of the gross energy of the ration. Arising therefrom, support is given to the system of expressing the nutritive value of feeding stuffs, and the nutritive requirements of animals, in terms of digestible protein and digestible nutrients or metabolizable energy.

Outbreaks of feather picking in the whale-meat meal groups occurred, whereas none occurred in the basal group. A possible explanation for these outbreaks is given in the text.

The presence of gizzard erosion was noted in all individuals in the whale-meat meal groups, whereas none occurred in the basal group.

HALNAN, E. T.

Rate of Growth as a Factor in the Incidence of Gizzard Erosion in Chicks.

Poult. Sci. 1942, **21**, 189–192.

The addition of whale meal to a low protein cereal mash increased the growth rate of chicks and caused the appearance of gizzard erosion.

It is suggested that the appearance of gizzard erosion so induced was due, not to the operation of a causative agent present in the whale meal, but to the increased growth rate caused by the addition of the whale meal supplement.

It is suggested that, where the addition of a supplement materially alters the growth rate normally obtained by use of the basal ration only, great caution should be exercised in interpreting results.

HALNAN, E. T.

War-time Poultry Feeding.

'Growmore' Bull. 5. *Minist. Agric.* (H.M.S.O., London, 1943. Price 3*d*.)

A practical guide on the use of war-time unrationed and substitute poultry feeding stuffs.

781* HALNAN, E. T. & FERMOR, C. E.

Surplus Potatoes in Poultry Feeding.

Agriculture : J. Minist. Agric. 1942, **49**, 175–179.

The results of field trials on the use of potatoes for chick rearing and for egg production indicated that satisfactory egg production can be obtained on a diet consisting of 4 parts by weight of cooked potato to 1 part by weight of a cereal food-fish meal mixture, and that such a diet, suitably reinforced with cod liver oil and dried yeast, can also be used for chick rearing.

HUNT, K., HALNAN, E. T., PEASE, M. S., ASHTON, T. & PAGE, D.

Feeding Trials with Household Garbage.

Harper Adams Util. Poult. J. 1943, **28**, 37–48.

Regular collections over a full year of unavoidable food waste were made from artisan households, averaging 2½ adults and 1 child.

Average daily quantities collected per household were 18·2 oz. Fresh material contained 4·2 oz. dry matter and 1·59 oz. protein. On a dry matter basis this 4·2 oz. of edible waste was made up as follows :— Bread 1oz., green vegetables ½ oz., vegetable peelings 2·4 oz., meat 0·3 oz.

Vegetable peelings, principally potato, supplied 68% of all the fresh material, 57% of the dry matter, and 46% of the crude protein in the total waste food collected.

Seasonal variation in quantity was considerable, collections being greatest in Autumn and smallest in Spring and early Summer.

Indications were obtained by feeding tests that efficient use could be made of cooked edible kitchen waste for egg production if a supplementary daily allowance per bird of approximately 2½ oz. of a suitable cereal and protein mixture were given in addition to free access to cooked kitchen waste.

In a subsequent test, no advantage as measured by egg production was obtained by substituting part of the Balancer meal by corn of war-time quality.

775* Wallace, L. R.

The Value of Pasture for Meal-Fed Pigs.

Emp. J. Exp. Agric. 1943, **11**, 168–174.

A method has been described for determining the value to fattening pigs of a pasture run-off as a supplement to a generous meal ration. In modified form this method might well be used with various species of farm stock to determine the value of many varieties of succulent crops under range conditions, and to study the effects of other environmental factors such as occur in practice.

Results have been obtained which suggest that by allowing pigs of between 30 and 120 lb. live-weight access to pasture in a young and nutritive stage of growth, a saving in meal consumption of the magnitude of 0·4 to 0·7 lb. meal per pig per day may be expected.

Evidence has been advanced which indicates that live-weight gains are less efficient in respect to meal consumption if pigs are allowed access either to a grass run-off of poor nutritive value, as is usually the case under drought conditions, or to a reasonably good run-off under cold or wet conditions.

From the data resulting from the two trials described, it is not possible to decide whether any benefit in respect to efficiency of live-weight gains is to be derived from allowing pigs of 120–200 lb. access to a first-class pasture run-off.

748* Woodman, H. E. & Evans, R. E.

The Chemical Composition and Nutritive Value of the Pea-Canning By-Products (Green Pea Pods, Pea-Pod Meal, Pea-Pod Silage and Molassed Silage from Pea Haulms with Pods).

J. Agric. Sci. 1944, **34**, 155–164.

The present paper deals with the composition and nutritive value of the following by-products of the pea-canning industry: (1) green pea-pods; (2) pea-pod meal resulting from the artificial drying of pea pods; (3) pea-pod silage as made in a tower silo; (4) molassed silage made in a sisalkraft silo from pea haulms with pods.

Pea pods give rise to an excellent silage provided they are tightly trampled and a means for draining off the effluent is supplied. The silage is pale yellowish green in colour and has a pleasant, vinegary smell with little or no suggestion of the presence of butyric acid. It is much relished by sheep and cattle. It is superior in digestibility to ' green fruity ' oat and vetch silage and contains, per 100 lb., 27·5 lb. of dry matter, including 15·9 lb. of starch equivalent and 2·3 lb. of digestible crude protein. No molasses need be added during filling, since the sugar naturally present in the pods ensures a favourable fermentation.

The pea haulms with pods, which came from the factory viners in a bruised condition and to which molasses was added during filling, also gave rise to a satisfactory silage, the character of which varied at the different depths of the sisalkraft silo. The upper layers had an olive green colour and a pleasant, ester-like smell suggestive of ' green fruity ' oat and vetch silage, whilst the lower layers were pale brown in colour and the presence of a little butyric acid could be detected. This change in quality was associated with marked differences in the ratio of volatile to non-volatile organic acids, a finding that emphasizes the danger of relying on the inspection and analysis of a single sample when attempting to assess the quality and type of silage produced in a given silo, even when the capacity of the silo is relatively small. Both the upper and the lower layers of silage, however, were readily eaten by sheep and cattle. The molassed silage from the pea haulms with pods had a somewhat lower digestibility than the pea-pod silage; it contained, per 100 lb., 23·6 lb. of dry matter, including 11·6 lb. of starch equivalent and 2·0 lb. of digestible crude protein. Its dry-matter content was lower than that of ' green fruity ' oat and vetch silage (27·3%), but when compared on the dry-matter basis, the two silages were not very different in respect of their content of starch equivalent and digestible crude protein.

Artificial drying of pea pods gives rise to a brown meal that lends itself admirably to incorporation in compound foods. It is of low palatability when fed alone. It has a satisfactory digestibility, approximately two-thirds of the food material which it contains being capable of digestion by ruminants. It contains, on the basis of dry matter, 59·6% of starch equivalent, including 6·4% of digestible crude protein.

The investigation of the feeding value of the pea-pod meal, pea-pod silage and molassed silage from pea haulms with pods was carried out by means of digestion trials with sheep. In the case of green pea pods, however, since these form a prominent ingredient of summer-collected household swill, it was considered desirable to determine their value in the feeding of bacon pigs. Further, since household swill must be processed or boiled before use, the pea pods were subjected to a thorough steaming before being fed to the pigs in the digestion trials.

The dry-matter content of pea pods from the canning factory varied from 10·8 to 14·4%. On the basis of dry matter, their crude-protein content showed a range of 13·5—17·0%, about one-third of which was in the form of non-protein nitrogenous material. The percentage of crude fibre varied from about 17% of the dry matter in the least mature samples to about 27% in the older pea pods, with a mean value of 23·5%. About two-fifths of the N-free extractives of the pea pods consisted of a mixture of sucrose and invert sugar.

The pigs received a daily ration composed of 400 g. of middlings, 400 g. of maize meal and 4000 g. of steamed pea pods. The meal and pea pods were fed separately in alternate portions during the day. Both animals, after thoroughly masticating the pods, consistently rejected relatively large masses of chewed, fibrous residue, swallowing mainly the fleshy, succulent part of the pods. ' Pockets ' of such fibrous material were frequently discerned in the dung, suggesting that constipation, with even a risk of stoppage, might conceivably result from the indiscriminate feeding of pea pods to pigs. The chewed residues had their origin in the inner parchment-like skins of the pea pods, which were found to contain, on the basis of dry matter, more than 40% of crude fibre. The rejected material formed 34·6% of the total dry matter in the pea-pod allowance of pig 1 and 52·5% in the case of pig 2.

The edible portion of the pea pods was digested to a fairly satisfactory extent, 68·3% of the organic matter in the eaten part being assimilated. If the chewed residue be regarded as indigestible matter, the digestion coefficient of the total dry matter in the whole pea pods is found to be very low (42·9% for pig 1 and 30·9% for pig 2). The more favourable results for pig 1 serve to illustrate how steamed pea pods are utilized by bacon pigs. The daily allowance of 4000 g. of pods contained 481·8 g. of organic matter. Of this, an average of 168·2 g. was discarded daily in the chewed residues, whilst of the 313·6 g. actually consumed, 211·9 g. (representing 44% of the total organic matter in the pods) was digested and assimilated. Assuming an average dry-matter content of 13% in the green pea pods, it may be inferred that 100 lb. of the pods, if fed to pigs, would supply 5·34 lb. of digestible organic matter.

Pig 1, when subsisting on the basal ration composed of equal parts by weight of middlings and maize meal, was able to derive 69·0 lb. of digestible organic matter per 100 lb. of meal consumed, and it follows that about 13 lb. of green pea pods would be required to supply as much digestible nutrient as is contained in 1 lb. of the meal mixture. The amount of energy expended by the pigs in chewing the pea pods was obviously greater than was needed for consuming the meal ration, and if this difference is taken into account, it is extremely probable that the conclusion from the present trial distinctly over-states the value of green pea pods for pigs. The final conclusion is drawn that although immature pea pods in the form of silage constitute a satisfactory food for ruminants, they have only a poor feeding value when fed, after steaming, to bacon pigs.

722* Woodman, H. E. & Evans, R. E.

Further Investigations of the Feeding Value of Artificially Dried Potatoes : The Composition and Nutritive Value of Potato Cossettes, Potato Meal, Potato Flakes, Potato Slices and Potato Dust.

J. Agric. Sci. 1943, **33**, 1–14.

The present account is a sequel to an earlier publication on the composition and feeding value of potato cossettes and meal. It deals with the composition, digestibility and nutritive value for pigs and ruminants of potato flakes and slices, the results of a large-scale pig-feeding trial with potato slices and the composition and value for pigs of potato dust, a by-product of the manufacture of potato slices. Details of the processes of production of these various dried potato products are included in the test.

From the results of the pig digestion trials it is concluded that all three forms of dried potatoes, when forming part of pig rations containing adequate supplies of protein and minerals, are superior to barley meal in feeding value and markedly superior to ground oats. The potato slices compare closely with maize meal, while the potato flakes have a value not far short of that of flaked maize.

Pigs are able to digest the dried potato products more efficiently than sheep, the means of all the determinations of the apparent digestion coefficients of the total organic matter in the cossettes, flakes and slices being 93·3% for pigs and 82·7% for sheep. Nevertheless, it is concluded from the results of the sheep digestion trials that, in feeding practice and with rations making adequate provision for protein and minerals, all three forms of dried potato products may replace barley, lb. for lb., in the rations of sheep and cattle.

The inclusion of potato meal, made by grinding the cossettes, in the pig's diet, or of any of the three types of dried potatoes in the diets of ruminants, may give rise to a very significant depression of the apparent digestibility of the protein in the ration as a whole. The depression is probably the consequence of an increased output of metabolic nitrogenous material in the faeces. Potato flakes and slices, on the other hand, appear not to exert any such effect when forming part of the rations of pigs.

The question is discussed as to which form of dried potatoes should be produced on a large scale for sale to pig feeders. It is shown that the decision must lie between the flakes and the slices, for potato meal (ground cossettes) is not only the least digestible of the dried potato products, but its inclusion in more than moderate amount in pig rations is liable to give rise to digestive disturbances and scouring and to a depression of the digestibility of the protein in the ration. The rate of production of the cossettes in the drying process is, moreover comparatively slow. The flakes are the most attractive in appearance and have the highest digestibility and nutritive value. They may be included liberally in pig dietaries without causing digestive disturbances, and they do not cause a lowering of the digestibility of the protein in such rations. For ruminants, however, they have the disadvantage of turning pasty during mastication, and for this reason, the cossettes and slices are probably more suitable for inclusion in the rations of sheep and cattle. The rate of production of the flakes by drying the cooked, mashed potatoes on the hot rollers is low.

The potato slices, while not possessing the attractive appearance of the flakes, are little behind them in respect of digestibility and feeding value. They may be fed to pigs on a liberal scale without causing digestive disturbances and without depressing protein digestibility. Further, the rate of their production in the Büttner driers of the beet-sugar factories is sufficiently high to enable large surpluses of potatoes to be conserved with the least delay. It is concluded that, of the various forms of dried potato products, the slices are likely to be available in largest supply for feeding to livestock, although it is probable that the cossettes will continue to retain the popularity they have gained among feeders of fattening cattle.

The value of potato slices for pigs was investigated further in farm-scale feeding trials, in which the control diet was an ordinary type of pig ration made up from white-fish meal, middlings, a mixture of equal parts by weight of maize meal and barley meal, together with a small amount of lucerne meal. In the second ration, 30% of the mixture of maize meal and barley meal was replaced by an equal weight of potato slices. The third ration was the same as the second up to the stage when the pigs had reached 100 lb. live weight, but beyond this stage the allowance of potato slices was increased to 60% of the total ration, this involving the replacement, lb. for lb., of the whole of the maize meal and barley meal and part of the middlings as well. It is concluded from the results of this trial that, provided the diet is suitably balanced in respect of protein and minerals, dried potato slices may replace cereals, lb. for lb., to a very liberal extent in the rations of bacon

pigs without causing digestive disturbances and without detriment to the rate of live-weight increase, the efficiency of food conversion and the quality of the resultant bacon carcass.

In a second farm-scale trial it is shown that the potato slices give satisfactory results when used as the supplemental bulky food in the Lehmann system of pig feeding. In this test the basal meal, which contained 10% of white-fish meal instead of the 30% of high-protein food usually considered necessary, was kept constant at 2½ lb. per head per day after a live weight of 50 lb. had been reached, and the total ration was made up to the normal level by the addition of potato slices.

The nature and composition of potato dust have been investigated. It is shown that this by-product may be fed to bacon pigs as a partial substitute for cereals without causing digestive disturbances, and that the most efficient usage will be obtained if (1) the introduction of potato dust into the diet is delayed until the pigs have reached about 80 lb. live weight, (2) the level of feeding is not increased beyond 30% of the total ration, and (3) the material is introduced gradually into the pig's diet.

735* Woodman, H. E. & Evans, R. E.

Further Investigations of the Nutritive Value of Swill : Starch Equivalent, and Seasonal Variation in the Composition and Feeding Value of Concentrated Swill.

J. Agric. Sci. 1944, **34**, 110–117.

An attempt has been made in the present communication to assess the value for pigs of urban swill collected during the winter months, when the main ingredients are potato peelings, cabbage leaves and other vegetable residues, and also during the summer months, at which period of the year the quality of the swill is at its lowest level, the product containing substantial proportions of pea pods, cabbage leaves and cabbage stalks. The form known as concentrated swill was used in the digestion trials, since regular and adequate supplies of this could be guaranteed, and, being already cooked, it did not require any heat treatment before feeding.

Chemical analysis showed that the winter swill, on account of the presence of the potato peelings, was distinctly richer in N-free extractives than the summer product. The latter, however, was richer in protein and lime, and, as a result of the replacement of potato peelings by pea pods as the main ingredient, displayed a much more fibrous character than the winter swill.

Digestion trials with pigs revealed the fact that the summer swill had a lower digestibility than the winter swill, although in the light of the digestion coefficients for the organic matter in potato peelings and green pea pods (91·8 and 38·3% respectively), the reduction in digestibility was not so considerable as might have been expected. The digestion coefficients of the organic matter and N-free extractives in the summer-concentrated swill were 77·4 and 88·0%, compared with 85·1 and 95·8% for the winter product.

On the basis of dry matter, the winter swill contained about 13% more digestible organic matter than the summer swill, the values being 76·79 and 68·19% respectively, compared with 67·88% for coarse middlings and 81·32% for barley meal. From this it was concluded that summer-concentrated swill, when compared on the same moisture basis, has a feeding value approximately equal to that of coarse middlings, and that 1 ton of the concentrated swill, as sold (69·86% moisture), is equal, in respect of content of digestible organic matter, to 0·35 ton of coarse middlings. The higher value of the winter product is illustrated by the finding that it contains as much digestible organic matter as a mixture of 2 parts by weight of barley meal and 1 part of coarse middlings, if the comparison be made on an equal moisture basis, and that 1 ton of the fresh-concentrated swill (68·1% moisture) has a feeding value for pigs equal to that of 0·37 ton of the cereal mixture, the corresponding value for the summer product working out at 0·31 ton. The coarse middlings referred to in the foregoing comparisons is the finer offal produced in the milling of wheat at the 75% rate of extraction.

One ton of *unprocessed* winter swill (25% dry matter) has a feeding value in pig rations equal to that of 0·29 ton of the mixture of 2 parts by weight of barley meal and 1 part of coarse middlings, whereas 1 ton of *unprocessed* summer swill (for which the lower average dry-matter content of 20% must be taken on account of the very high moisture content of the included pea pods) has a nutritive value about equal to that of 0·23 ton of coarse middlings (75% extraction). These comparisons presuppose that the unprocessed urban swill is boiled for at least an hour before feeding.

Winter-concentrated swill was found to be digested by sheep to a very satisfactory extent, 82·1% of the organic matter in the product being assimilated. On the basis of dry matter, the concentrated swill contained 75·2% of starch equivalent, including 8·03% of digestible crude protein. On the fresh basis (70·25% moisture), 1 ton of the product contained as much starch equivalent as 0·34 ton of a mixture of 2 parts by weight of barley and 1 part of coarse middlings (70% extraction), a finding that is consistent with the results of the pig digestion trials.

727* H. E. Woodman & R. E. Evans

The Influence of War-time Milling Control on the Composition, Digestibility and Nutritive Value of the Wheaten Offals.

J. Agric. Sci. 1944, **34**, 35–48.

The investigations described in this paper are concerned with the influence of the various war-time changes in milling practice on the composition, digestibility and nutritive value, both for ruminants and pigs, of the wheaten milling offals. The need for obtaining a larger output of flour for human consumption led to the raising of the rate of flour extraction from 70 to 75% at an early stage of the war, and this was increased further to 85% with the introduction of the ' national wheat-meal loaf ' in 1942. Two grades of wheaten offal

only were marketed at this stage of the war—fine bran and coarse bran. Early in 1943 it became permissible to incorporate a proportion of rye, barley or de-husked oats in the wheat before milling. It was considered unlikely that the inclusion of rye or de-husked oats would exert any adverse influence on the nutritive value of the milling offals. When barley is used to dilute the wheat, however, the husk from this grain finds its way into the offals, and it was therefore to be anticipated that the presence of the barley husk would cause the fibre content of the offals to be raised and their nutritive value to be lowered. Authority has been given for the use of a grist that will give rise to a flour containing up to 10% of barley flour, but at the time of writing it would appear that, in actual practice, flour millers have not exceeded 10% of barley in the grist itself.

The following grades have been submitted to investigation in the present series of tests: (1) fine wheatfeed (75% extraction) ; (2) fine bran and coarse bran (85% extraction) ; (3) fine millers' offals and coarse millers' offals (85% extraction, with 10% of barley added to the wheat before milling).

The raising of the level of extraction from 70 to 75% had the effect of increasing the fibre content of the fine wheatfeed from 6·98 to 8·59% (dry-matter basis). The corresponding values for the other grades were : fine bran, 10·82% ; coarse bran, 11·85% ; fine millers' offals, 11·87% ; coarse millers' offals, 15·46%. It may be noted, for comparison, that pre-war bran, on the dry-matter basis, had a fibre content of 10·92%. A close correspondence in chemical composition was found between coarse bran (85% extraction) and pre-war broad bran (70% extraction).

The results of the sheep digestion trials show that the digestibility of the offals decreases with increasing fibre content, the digestion coefficients of the organic matter in the different grades being 70·6% for fine wheatfeed, 66·6% for fine bran, 63·6% for coarse bran, 66·1% for fine millers' offals and 57·9% for coarse millers' offals. The raising of the percentage extraction from 70 to 85% does not lead to any serious depression of the nutritive value of the coarse fraction of the offals, coarse bran (85% extraction) being little inferior to pre-war bran (70% extraction) in respect of starch equivalent. The finer grade of offals, on the other hand, suffers a very marked decline in quality as a result of the increased rate of flour extraction. Indeed, fine bran is little different from pre-war bran in content of fibre, digestible protein and starch equivalent. Its starch equivalent (44·0) compares very unfavourably with that of pre-war fine wheatfeed (57·8). It is also evident from the results that the fine offals suffer a bigger drop in starch equivalent as the rate of extraction rises from 70 to 75% than when the rate is increased from 75 to 85%.

The addition of 10% of barley to the wheat before milling does not give rise, in the case of ruminants, to any significant additional depression of the digestibility and nutritive value of the finer grade of offals (fine millers' offals), which, like fine bran, has a starch equivalent approximating to that of pre-war bran. The main effect of the presence of barley husk is seen in the coarse millers' offals, which have the low starch equivalent of 34·9, a value that is no higher than that of good meadow hay. This type of coarse offals has only four-fifths of the value of pre-war bran. It is still balanced for milk production, but an allowance of 7 lb. would be needed to supply the requirements for a gallon of average milk.

From the results of the pig digestion trials it is concluded that the coarse grades of wheaten offals may form up to one-third of the total rations of bacon pigs of more than 120 lb. live weight without risk of scouring or other digestive disturbances, a finding in sharp contrast to the pre-war belief that bran, on account of its bulky and laxative character, should never be included to the extent of more than 10% in the diets of growing or fattening pigs.

The fall in digestibility with increasing fibre content is noted also in the results of the pig digestion trials, the digestion coefficients of the organic matter in the various grades being 71·2% for fine wheatfeed, 67·9% for fine bran, 56·5% for coarse bran, 58·5% for fine millers' offals and 47·9% for coarse millers' offals. The corresponding values, on the basis of dry matter, for the total digestible nutrients were 72·9, 68·7, 55·3, 59·0 and 47·1% respectively. The fall in digestibility and nutritive value in passing from fine wheatfeed (75% extraction) to fine bran (85% extraction) is not very considerable, but the results of the sheep tests indicate that there may be a very distinct fall in the nutritive value of fine wheatfeed as the rate of extraction rises from 70 to 75%. Unfortunately, in the case of pigs, the writers have no digestion data for pre-war wheaten offals with which to compare the values obtained in the present investigation for the war-time milling offals.

The fine millers' offals are distinctly poorer for pigs than fine bran, a disparity that is scarcely discernible in the results for the sheep. It is concluded, therefore, that a proportion of the fine part of the barley husk finds its way into the fine millers' offals, and that, as might be expected, sheep are able to digest this fraction more efficiently than pigs.

The bulkiness, low digestibility and poor nutritive value of the coarse millers' offals (containing barley husk) render this grade unsuitable for inclusion in more than small amount in the diets of bacon pigs. Indeed, of the different grades tested in these trials, only the fine wheatfeed and fine bran are really suitable for use as major components of the rations of growing and fattening pigs.

The grinding of coarse bran in the hammer mill to the fineness of fine bran gives rise to only an unimportant increase in the digestibility of this by-product. Before grinding, pigs were able to assimilate 56·5% of the organic matter in the coarse bran ; after grinding, the amount digested rose to 59·8%. It is concluded that the resulting improvement, of the order of 6%, is insufficient to repay the cost of the labour and power involved in the practice.

There is little notable difference in the extent to which pigs and sheep are able to digest the finest grades of the milling offals, namely, fine wheatfeed and fine bran. On the other hand, sheep are undoubtedly superior to pigs in their capacity for assimilating the coarser grades (coarse bran, fine millers' offals and coarse millers' offals), the distinction in favour of the sheep being particularly marked in the case of the coarse millers' offals.

A graph is given by means of which the *approximate* starch equivalent of any given consignment of milling offals may be deduced from a knowledge of its fibre content.

723* Woodman, H. E. & Evans, R. E.

The Nutrition of the Bacon Pig. VIII. The Value of Lawn-Grass Cuttings in the Feeding of Bacon Pigs.

J. Agric. Sci. 1943, **33**, 101–112.

The results of digestion trials carried out some years ago in this Institute have led to the belief that *at least* 6–7 lb. of young, leafy grass is needed to replace 1 lb. of ordinary pig meal in the rations of bacon pigs. More recent farm-scale feeding trials at the Harper Adams Agricultural College have given rise to the conclusion that no more than 1½ lb. of young grass is required for this purpose when the pigs are receiving, in addition to the grass, a basal allowance of 2½ lb. of balanced meal per head per day. The present experiments were undertaken with the object of throwing further light on these conflicting views.

The following three treatments were compared in a feeding trial carried out by the technique of individual feeding. The control pigs (treatment C) were kept on a balanced, all-meal diet throughout, the daily allowance of meal being scaled so as to reach a maximum of 7 lb. per head per day at 200 lb. live weight. The pigs on treatment A received the same all-meal ration as the control pigs up to 50 lb. live weight, at which stage they were consuming 2½ lb. of meal per head per day. From this stage until the end of the 21st week of the trial, the daily meal allowance was kept constant at 2½ lb., the ration being brought up to the level of that of the control pigs by a supplement of lawn-grass cuttings calculated on the basis of the Harper Adams College finding that 1¼ lb. of such grass is equal to 1 lb. of meal. Treatment B merely differed from treatment A in that the introduction of the young grass was deferred until the young pigs had reached 60 lb. live weight, the meal allowance then being stabilized at 3 lb. per head per day and the ration brought up to the level of that of the control pigs in the manner described for the animals on treatment A. In addition to the three groups of individually fed pigs, a separate group-fed lot (treatment D) was set aside for testing the value of lawn-grass clippings when fed *to appetite* as a supplement to an allowance of 2½ lb. of balanced meal per head per day.

The young grass fed throughout the trial was of high quality, averaging 21·2% of crude protein on the basis of dry matter and containing, on an average, 29·5% of dry matter. The comparison was begun on 13 April, 1942, when the pigs on treatments A, B, C and D averaged 37·0. 36·9, 36·3 and 39·1 lb. respectively, and lasted until 7 September, after which date the supply of grass became too uncertain to permit of a continuation of the comparison. By this date the average live weight of the control pigs was 211·1 lb., whilst the A, B and D pigs averaged 143·9, 156·8 and 155·5 lb. respectively. These results reveal the marked superiority of the all-meal diets over the diet composed partly of meal and partly of lawn-grass cuttings. The disparity would have been even more pronounced had the experiment been continued until all the pigs in the trial had reached 200 lb. live weight, for the control pigs, at the end of the grass-feeding period, were averaging about 10 lb. live weight increase per week, compared with but 5 lb. or less for pigs on the other treatments. Indeed, the results for the D pigs suggest that young, leafy grass is not sufficiently nutritious *for pigs* to enable a young piglet, receiving a daily allowance of 2½ lb. of meal and young grass up to appetite, to reach the slaughter weight of 200 lb. even when the period of feeding extends over the greater part of the entire grass season.

More detailed analysis of the results showed that the A pigs required, on an average, 43·1 days longer than the control animals to grow from 50 to 140 lb. live weight, the saving of meal amounting to only 13·6 lb. per pig ; the B pigs needed 27·5 days longer, with a saving of 6 lb. of meal per pig, whilst the D pigs took 30·7 days longer, the saving of meal in this case being 45·8 lb. per pig. Only by feeding the grass to appetite, therefore, was it possible to effect any noteworthy saving of meal, but when the labour of cutting the grass and feeding the pigs over the extra period of 31 days are taken into account, it is difficult to resist the conclusion that the feeding of mown lawn grass to bacon pigs on any large scale is, in peace-time at any rate, an uneconomical procedure.

The results for the B and D pigs afford the best basis for assessing the meal-replacing value of young grass, for the animals in these two groups grew, on an average, from 50 to 140 lb. live weight in an almost equal number of days (103 and 106 days respectively). During this period the D pigs, on an average, consumed 39·8 lb. less meal but 309·8 lb. more grass (83·9 lb. of dry matter) than the B pigs, so that the grass consumption was 7·8 lb. (2·1 lb. of dry matter) for every 1 lb. of meal saved. This result is not inconsistent with the conclusion from the results of the earlier digestion trials, namely, that 6–7 lb. of young grass (1·2–1·4 lb. of dry matter) contains as much digestible organic matter as 1 lb. of pig meal, for the ideal figure from the digestion trial takes no account of the fact that the expenditure of muscular energy by pigs when consuming grass is greater than is needed for the consumption of an equal weight of ordinary meal.

That under certain conditions the amount of grass consumed for every 1 lb. of meal saved may be very considerably higher than this figure, however, is manifest from the comparison of the A and B treatments with the control treatment. Over the period from 50 to 140 lb. live weight, 20·1 lb. of grass (5·6 lb. of dry matter) was fed for every 1 lb. of meal saved in the case of the A pigs. and as much as 29·5 lb. (8·2 lb. of dry matter) in the case of the B pigs. These high values are the result of the longer interval required by the grass-fed pigs to grow from 50 to 140 lb. live weight as compared with the control pigs, for much of the net energy of the grass, which would otherwise have been utilized for growth and fattening, was used to provide the additional requirements for maintenance over the extra days of feeding.

At the end of the grass-feeding period on 7 September, the grass-fed pigs on treatments A, B and D were not merely substantially below the normal bacon weight of 200 lb., but had also failed to reach the condition required for the production of a satisfactory bacon carcass. They were of the ' grey-hound ' type, high on the leg and thin along the back, having good frames but lacking flesh and fat. They were therefore kept a month on an all meal ration to enable them to gain the desired ' finish '. During this final period, the A and B pigs made significantly better and more economical progress than the control pigs, the results again demonstrating the clear superiority of the all-meal diet over the grass-containing diet and showing that the poorer results for the A and B pigs during the grass-feeding period were not to be ascribed to an absence of the normal growth impulse in these animals.

724* Woodman, H. E. & Evans, R. E.

The Nutrition of the Bacon Pig.

IX. The Lehmann Method of Pig Feeding, with particular Reference to the Balance of the Basal Meal and the Use of Cooked Potatoes and Molassed Beet Pulp as the Supplemental Foods.

J. Agric. Sci. 1943, **33**, 155–168.

When ' mineralized ', cooked potatoes are fed as the bulky supplemental food in the Lehmann system of pig-feeding, and the basal meal allowance is restricted to 3 lb. per head per day, bacon pigs are able to make as good progress, in respect both of rate of live-weight increase and economy of food conversion, and at every stage from 60 to 200 lb. live weight, as they would if kept on a diet composed wholly of balanced meal. In the present trials, pigs of about 200 lb. live weight were able to consume 15–17 lb. of cooked potatoes per day in addition to the daily allowance of 3 lb. of meal. It required, on an average, about 1030 lb. of cooked potatoes and 311 lb. of balanced meal per pig to fatten the animals from 60 to 200 lb. live weight. The cooked potatoes, when assessed on the air-dry standard of 13% moisture, were able to replace the balanced meal on a lb. for lb. basis without detriment to the progress of the pigs, and the average saving of meal thus made possible amounted to about 225 lb. per pig, or 38·2% of the total meal consumed per pig on the control, all-meal diet.

Cooked potatoes should be introduced into the ration gradually and the allowance should be scaled according to live weight in the manner adopted in the present trials. When the amount to be fed is large, it is best to feed ' mineralized ', cooked potatoes only during the morning and to place the basal meal in the trough towards the end of the afternoon. The meal, on account of its palatability, will then be eaten readily, and any small amount of cooked potatoes still remaining in the trough will be licked up cleanly at this feed. If these precautions are observed, no ' scouring ' or undue ' blowing ' need be feared.

The pigs receiving the cooked potatoes gave carcasses that were suitable in every respect from the standpoint of the bacon curer.

No advantage is to be secured by feeding a basal meal containing more than 10% of white-fish meal, or its equivalent of other protein-rich food. In the present trials a basal meal containing 10% of white-fish meal (15·5% of digestible protein) was compared against one containing 15% of fish meal (17·8% of digestible protein) and also against a conventional Lehmann basal meal containing 20% of fish meal and 10% of bean meal (20·7% of digestible protein). In all three cases the allowance of basal meal was restricted to 3 lb. per head per day. The low-protein basal meal proved as satisfactory in every respect as the high-protein mixture, and it may be concluded further that if this is so when the supplemental food consists of potatoes, which are poor in protein, it is also true when protein-rich green foods are used as the supplemental food. The finding enables a troublesome feature of the Lehmann system to be eliminated, in that it is no longer necessary at 50–60 lb. live weight to change over from a meal containing 10% of high-protein food to one containing 30%.

' Mineralized ' molassed beet pulp proved less satisfactory than ' mineralized ' cooked potatoes as a supplemental food in the Lehmann system of feeding. The introduction of the beet pulp at 60 lb. live weight as a supplement to the basal meal allowance of 3 lb. per head had the effect of causing the diet to be much more bulky than the control, all-meal diet, and for this reason the pulp-fed pigs were unable to consume the same weight of food as the control animals. It was concluded that a 200 lb. pig could not be expected to deal with more than 3 lb. of beet pulp in addition to a daily allowance of 3 lb. of basal meal. The control pigs at this live weight were consuming, without difficulty, a daily ration of 7 lb. of ordinary pig meal. The molassed pulp was fed after thorough soaking in twice its weight of water.

As in the potato trials, the efficiency of a basal meal containing only 10% of white-fish meal was compared, in the pulp trial, against that of a conventional Lehmann basal meal containing 20% of fish meal and 10% of bean meal. A control treatment, in which the pigs were kept on a standard, all-meal diet, was also included. From 60 to 100 lb. live weight, over which period the pulp averaged 13–14% of the total ration, the two Lehmann groups made as good progress as the control group. Beyond 100 lb. live weight, however, the control group went ahead of the Lehmann groups in respect both of rate of live-weight increase and efficiency of food conversion, an effect that was to be attributed not so much to factors of digestibility as to the restrictive influence on food consumption arising from the bulkiness of the pulp diet and also to the greater expenditure of energy by the pulp-fed groups in consuming their rations. From about 36 lb. live weight to slaughter weight at about 207 lb., the pulp-fed group receiving the low-protein basal meal averaged 1·11 lb. live-weight increase per day, compared with 1·22 lb. in the case of the control group. The corresponding average figures for lb. food per lb. live-weight increase were 3·96 and 3·75 lb. respectively. The amount of pulp consumed per pig over this period averaged 241·6 lb., and this resulted in a saving of 217·4 lb. of meal, the pulp-fed animals requiring, on an average, 11 days longer than the control pigs to make this live-weight gain. The pulp-fed pigs on the conventional, high-protein Lehmann basal meal displayed a lower degree of thriftiness, averaging a daily live-weight gain of 1·02 lb., with a food requirement of 4·51 lb. of live-weight gain. This poorer result is attributed to the laxative nature of the diet, resulting from a combination of the effects of the high protein content of the basal meal and the high sugar content of the molassed beet pulp.

The pulp-fed animals lacked the bloom of the pigs on the all-meal diet ; they were flabbier and had not the same depth and finish. The greater leanness and poorer finish of the animals on the pulp diet was confirmed by the post-slaughter data for carcass percentage, back fat, belly streak and factory grading.

754* Woodman, H. E. & Evans, R. E.

The Nutrition of the Bacon Pig.

X. The Value of Extracted Palm-Kernel Meal in the Feeding of the Bacon Pig.

J. Agric. Sci. 1945, **35**, 44–55.

From time to time during the course of the present war, pig feeders have reported that they have experienced considerable difficulty when making use of extracted palm-kernel meal as a major constituent of the

rations of bacon pigs. This has been attributed partly to the lack of palatability of the extracted meal, which leads to a reduction in food consumption and a consequent depression in the rate of live weight increase, and partly to its high fibre content, which causes the ration to be somewhat bulky and of lowered digestibility and nutritive value. The present experiments were designed to throw light on these somewhat contentious matters, since little guidance is to be obtained from the scanty references to this subject in the scientific literature dealing with animal nutrition.

The results of digestion trials with pigs showed that the organic matter in extracted palm-kernel meal is 68·8% digestible. Digestion coefficients of 60·0 and 76·8% were obtained respectively for the crude protein and N-free extractives of the meal. Per 100 lb. of dry matter, extracted palm-kernel meal contains 65·8 lb. of digestible organic matter, compared with 65·4 lb. in farm-ground oats, 67·9 lb. in coarse middlings (75% extraction) and 64·5 lb. in fine bran (the fine wheat feed resulting from milling at the 85% rate of extraction). It may be concluded, therefore, that all these feeding stuffs are of approximately equal value in the feeding of bacon pigs. The extracted meal contains no more than 12·1% of digestible crude protein, and therefore must not be regarded as a protein-rich food for pigs. Its inclusion in pig rations does not enable the pig feeder to reduce the amounts of protein-rich food, such as white-fish meal or extracted, decorticated ground-nut meal, that must be fed to make provision for the protein requirements of bacon pigs.

Farm-scale pig-feeding trials were carried out to test the suitability of extracted palm-kernel meal for bacon pigs when fed at different levels in replacement of fine bran. Both the individual feeding and group feeding techniques were employed. From 50 to 90 lb. live weight, 17% of extracted palm-kernel meal was used to replace an equal weight of fine bran. At this level the ration containing the extracted meal was eaten readily and cleanly, and was slightly, but not significantly, superior to the control ration, as judged by the mean rate of live weight increase per day and the economy of food conversion. The dung from the pigs receiving the extracted meal remained perfectly normal over this period.

The individually fed pigs on treatment A (control ration) and on treatment B (17% extracted palm-kernel meal) continued unchanged on their respective diets from 90 to 150 lb. live weight, but those on treatment C had their allowance of the extracted meal increased gradually from 17 to 32%, again in replacement of an equal weight of fine bran. The C pigs continued to feed quite normally ; the full rations were consumed without difficulty, and the dung remained normal in consistency. Their progress over this period was slightly, though not significantly, better than that of the control animals. On the other hand, the B pigs, receiving 17% of extracted palm-kernel meal, gave significantly better results than the control pigs in respect both of the rate of live weight increase and efficiency of food conversion, and it may be concluded that the extracted meal, when restricted to 17–32% of the total ration, is slightly superior to fine bran as a food for bacon pigs, a finding that is in harmony with the results of the digestion trials.

Beyond 150 lb. live weight the extracted meal was increased to 50% for the B pigs and to 60% for the C pigs. In both cases the palm-kernel by-product replaced an equal weight of wheat-milling by-product, which at the beginning of this final period consisted of fine bran, but which was later gradually changed over to fine millers' offals (a by-product of the milling, at the 85% rate of extraction, of wheat containing 10% of barley). The control diet was now composed of 85% of milling by-product, 10% of extracted, decorticated ground-nut meal (with an appropriate mineral supplement) and 5% of lucerne meal. On this diet, over the range of live weight from 150 to 195 lb., the control animals averaged 1·07 lb. of live weight increase per day, with a mean requirement of 6·09 lb. of meal per lb. of live weight gain, an illustration of the poor results that may be expected from pigs subsisting on war-time rations containing very high proportions of fine bran or fine millers' offals.

Although the change of ration was made in a very gradual manner, it soon became evident that the raising of the percentage of extracted palm-kernel meal to 50% for the B pigs and to 60% for the C pigs caused the rations to be bulky and distinctly unpalatable. The appetites of the pigs on these treatments fell off as a consequence, although the control pigs, on a ration containing as much as 85% of milling by-product, continued to consume full rations. At 180 lb. live weight the daily food consumption of the control pigs averaged 6·7 lb. compared with 6·0 lb. for the B pigs and 5·8 lb. for the C pigs. Moreover, the dung from the pigs receiving these high allowances of the extracted meal at times became rather soft, although there was no actual scouring.

Despite the falling off in food consumption consequent on the lowered palatability of the diet, the B pigs averaged 1·03 lb. of live weight increase per day over this final period, a value not significantly lower than that for the control animals, whilst a significantly smaller amount of meal (5·61 lb.) was required, on an average, per lb. of live weight gain. From this it may be concluded that the extracted meal is definitely superior, as a food for bacon pigs to the grade of fine millers' offals (containing barley husk) that was used in the present trials, a conclusion that is in agreement with the findings of the digestion trials.

In the case of the C pigs receiving 60% of the extracted meal in their rations, food consumption was depressed in a still higher degree, and the mean rate of live weight increase declined as a consequence to 0·93 lb. per day, with a food conversion factor of 6·0 lb. of meal per lb. of live weight gain.

The group-feeding trials gave results of a confirmatory nature, and the general conclusion is drawn that the optimum *maximum* level of feeding extracted palm-kernel meal to bacon pigs lies in the neighbourhood of 30–35% of the total ration. At or below this level the unpalatable character of this feeding stuff is masked by the other ingredients of the diet, no depression of food consumption occurs, and the extracted meal exerts an effect in the ration at least equal to that of fine bran. Beyond this level, however, the unfavourable effect of the extracted meal on the palatability of the diet is liable to cause a reduction of daily food intake, and this may be aggravated if the other war-time ingredients of the diet are in themselves not very palatable.

Extracted palm-kernel meal is too fibrous for inclusion in more than very small amount in the rations of newly weaned pigs. At 50 lb. live weight, however, the amount may gradually be increased to 15–20% of the total ration. After the pigs have attained 100 lb. live weight, the percentage may be further increased to about 33%, and if the pig feeder has an adequate supply of other foods, the percentage may well be maintained

at this level up to slaughter weight. Should circumstances, such as a shortage of cereal meal or wheatfeed, make it necessary, however, the extracted meal may be raised to still higher levels at about 150 lb. live weight, particularly if the other ingredients of the diet are of a palatable nature. Such increase may lead to some depression of the daily food intake of the pigs and may at times cause them to be rather ' loose ', but nevertheless it should be possible to bring the animals steadily along to bacon weight at the rate of about 1 lb. live weight increase per day and to produce a ' finish ' that will be satisfactory to the curer. A point of primary importance to keep in mind is that when introducing extracted palm-kernel meal into the diet, or when increasing the amount already being fed, the changes should be made gradually.

798* Woodman, H. E. & Evans, R. E.

Nutrition of the Bacon Pig.

XI. The Minimum Level of Protein Intake Consistent with Quick Growth and Satisfactory Carcass Quality (Part IV).

J. Agric. Sci. 1945, **35**, 133–149.

The main object of the present investigation was to test the inference from the results of previous trials that a diet composed substantially of cereal and weatings, with a small percentage of lucerne meal or grass meal, and supplying 7% of white-fish meal up to 90 lb. live weight and no protein supplement at all thereafter, should provide all the protein needed for the maximum rate of growth in bacon pigs and the production of carcasses of satisfactory quality, when fed at the rates shown in the feeding chart in Table 3.

Two separate trials were carried out, and both the individual-feeding and group-feeding techniques were employed. In Trial I the control treatment A supplied the standard allowances of high-protein supplement, consisting of 10% of white-fish meal from weaning to 150 lb. live weight, and 5% of extracted soya-bean meal from 150 lb. to slaughter at about 200 lb. The white-fish meal in the rations of the pigs on treatment B was restricted to 7% up to 90 lb. live weight, and from this stage onwards the high-protein supplement was entirely omitted from the diet. The rest of the diet in both treatments consisted of barley meal and weatings, with a small percentage of lucerne meal, care being taken also to safeguard the animals against mineral deficiencies.

The control treatment A in Trial II provided 7% of white-fish meal from weaning to 150 lb., and 10% of bean meal from 150 to 200 lb. live weight. In treatment B the 7% of white-fish meal was replaced by 16% of bean meal plus 2% of blood meal, and the barley meal was reduced by 11%, so that up to 150 lb. live weight, the ration of the B pigs contained as much digestible protein as the control ration. From 150 lb. onwards, the protein supplement in the diet of the B pigs consisted of 5% of bean meal. The animals on treatment C received rations comparable with those of treatment B in Trial I. They were kept on a diet containing 16% of bean meal and 2% of blood meal (equal to 7% of white-fish meal plus 11% of barley meal in respect of digestible protein) up to 90 lb. live weight, and from this stage onwards the protein supplement was left out of the rations. The remainder of the diets in all three feeding treatments, which were designed so as to supply equal amounts of net energy, consisted of barley meal and weatings, with a small allowance of lucerne meal. The daily rations were scaled according to the provisions of the feeding chart in Table 3, and, as in Trial I, precautions were also taken to safeguard the experimental animals against any risk of mineral deficiency.

The main findings of the trials are :

Trial I. From the beginning of the feeding period at about 46 lb. live weight up to 90 lb. live weight, the B pigs receiving 7% of white-fish meal in their rations made as good progress in every respect as the A pigs receiving the standard allowance of 10%. From 90 to 150 lb. live weight, the results for the A pigs, still receiving 10% of white-fish meal, were somewhat better than those for the B pigs, which now were receiving no high-protein supplement in their rations, whilst from 150 to 200 lb. live weight the pigs on treatment B, receiving no protein supplement, made slightly better progress than the A pigs, now receiving 5% of extracted soya-bean meal in their diet.

Over the *entire* feeding period (46–200 lb. live weight), however, there were no statistically significant differences between the results for the pigs on the standard-protein and low-protein diets, whether the comparison be based on the mean number of days required to reach 200 lb. live weight, the mean daily rate of live-weight increase, or the mean lb. meal consumed per lb. live-weight gain. Over this period the individually fed pigs on the low-protein treatment B consumed, on an average, 9·0 lb. of white-fish meal per head, compared with 44·6 lb. per head (including the extracted soya-bean meal fed from 150 to 200 lb. live weight) in the case of the animals on the standard-protein diet A.

Trial II. From the initial weight of 36–37 lb. up to 90 lb. live weight, there were no significant differences between the mean results for the pigs on the three different feeding treatments,. The B and C pigs over this period were subsisting on the same diet containing 16% of bean meal plus 2% of blood meal, whilst the control animals on treatment A were receiving a ration containing an equal amount of digestible protein and net energy, the only difference being that the protein supplement was provided in the form of 7% of white-fish meal.

From 90 to 150 lb. of live weight, the A and B pigs continued unchanged on their respective diets, and again there were no significant differences between the mean results for the pigs on these two treatments, the ration containing the mixture of bean meal and blood meal proving equal in every respect to the control ration containing white-fish meal. As in Trial I, however, the withdrawal of the protein supplement at 90 lb. live weight caused the pigs on treatment C to display slightly less thrifty progress than the A and B pigs over this period.

From 150 to 200 lb. live weight, the B and C pigs made almost equal progress, whilst the results for the A pigs were somewhat poorer, though not significantly so. This finding confirms the conclusion from Trial I that with a ration composed substantially of cereal meal and weatings, a protein supplement is not necessary to ensure the maximum thriftiness during the finishing period.

The data for the *whole* feeding period up to 200 lb. live weight revealed a close agreement between the mean results for the pigs on the three feeding treatments in respect both of mean daily rate of live-weight increase and efficiency of food conversion, the observed small differences being statistically non-significant. The replacement, on an equal digestible protein basis, of the fish meal in the control ration by the mixture of bean meal and blood meal had no significant effect on the progress of the pigs over the period as a whole. Further, the omission of the mixture of bean meal and blood meal from the diet of the C pigs at 90 lb. live weight caused no significant depression of the mean daily rate of live-weight gain or the mean deficiency of food conversion over the whole feeding period, a finding in harmony with the conclusion from Trial I, namely, that a cereal-weatings diet containing 7% of white-fish meal (or its equivalent of other animal protein, or mixture of vegetable and animal protein) up to 90 lb. live weight, and no high-protein supplement at all thereafter, will supply sufficient protein, when fed according to the ration scales in Table 3, to ensure the maximum rate of growth and thriftiness in bacon pigs. Further work is being carried out to ascertain whether this conclusion still holds good when animal protein is replaced completely by vegetable protein.

Both trials agree in showing that the omission of the protein supplement at 90 lb. live weight caused the animals subjected to this treatment to be slightly less thrifty than the control pigs over the period from 90 to 150 lb. live weight, and it may be that the ration of barley meal, weatings, minerals and lucerne meal was supplying somewhat less protein than was needed for maximum growth at this stage. It is possible, therefore, that a more satisfactory comparison with the control pigs might have been obtained if the protein supplement had been reduced gradually at 90 lb. and finally omitted at about 120 lb. live weight. On the other hand, it is also possible that the mere changing of the diet may have given rise to a slight, temporary setback in the progress of the pigs on the low-protein treatment and have thus contributed to the observed differences, since the animals on the other treatments were not subjected to corresponding changes of diet at 90 lb. live weight. In any case the small differences noted in this period were of minor practical significance, since their effect could not be discerned when the results of the feeding trial as a whole were submitted to statistical analysis.

The results of the post-slaughter measurements showed that the pigs on the low level protein supply gave carcasses that were not significantly different in respect of conformation and leanness from those obtained from the comparable animals subsisting on diets supplying the standard amounts of protein supplement, and it is concluded that provided the reduced protein supply is sufficient to support the maximum rate of growth, no significant falling off in carcass conformation or leanness need be feared.

721* WOODMAN, H. E. & EVANS, R. E.
The Value of Potato Peelings in the Nutrition of the Bacon Pig.
J. Agric. Sci. 1943, **33**, 15–17.

Mechanical peeling of potatoes removes an exceedingly thin skin that is notably richer in ether extract, fibre and lime, but much poorer in N-free extractives, than the thicker parings obtained by ordinary hand peeling. The latter, in respect of their general composition, do not differ to any marked extent from whole potatoes.

The results of digestion trials with pigs have shown that potato peelings, *after cooking*, are highly digestible when included in the rations of bacon pigs. The N-free extractives, which form about 80% of the dry matter of the hand peelings, have a digestion coefficient of 96·2%. An allowance of 5 lb. of such peelings supplies as much digestible organic matter as 4 lb. of whole potatoes, and it is concluded that 1 lb. of barley meal in the rations of bacon pigs may be replaced by 4lb. of potatoes or by 5 lb. of potato peelings. Both the potatoes and the potato peelings should be cooked before feeding.

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ANIMAL PHYSIOLOGY

725* CHANG, M. C.
Disintegration of Epididymal Spermatozoa by Application of Ice to the Scrotal Testis.
J. Exp. Biol. 1943, **20**, 16–22.

Testes of rabbits were cooled with ice applied to the scrotum for 10 mins. Disintegrated spermatozoa (95–24%) appeared in the ejaculates 24 hr. after treatment. Morphological disintegration takes a few hours but physiological deterioration appears rather more quickly. The proportion of disintegrated spermatozoa depends on the duration of treatment. The occurrence of disintegrated sperms in the ejaculate lasted about 10 days, depending on the rate of evacuation of disintegrated sperms from the cauda epididymis. There was no adverse effect of ice treatment on sex drive and spermatogenesis. The testes of rabbits, rats and guinea-pigs were treated with ice for 10–20 min. About 20–30% of disintegrated sperms was found in the cauda epididymis of rabbits and rats but not in guinea-pigs.

802* Day, F. T. & Hammond, J. Jun.

Lactation in Heifers Induced by Oestrogen Implants.

J. Agric. Sci. 1945, **35**, 150–157.

Average lactation curves have been prepared from selected animals in a group of heifers treated for 60 or 100 days with stilboestrol or hexoestrol tablet implants. A treatment period of 100 days appears to give poorer results than one of 60 days. The optimum duration, on the average, is probably about 75 days, but seems to depend upon the way lactation develops—which bears no obvious relationship to the amount of oestrogen absorbed.

A rise in yield follows tablet removal whether this is done while the yield is still rising or after it has begun to decline. Yield in an induced lactation may fall very far short of the animal's inherent capacity, but comparison between induced lactations and those at subsequent calvings shows that it may very nearly approach what would be a normal yield.

A heifer which was treated twice did rather less well in her second induced lactation.

Breeding histories of a number of implanted heifers are outlined. They were all animals which had failed previously to get in calf. 5–10% (without further treatment) did not return to an ovulatory cycle. About 70% of anatomically normal heifers got in calf, the service rate being about 2·6. A rather high incidence of abortions may be a feature of a recovery period from treatment, but may have been due to selection of animals with such a tendency.

773* Hammond, J.

Physiological Factors Affecting Birth Weight.

Proc. Nutrit. Soc. 1943, **2**, 8–14.

A theory of foetal nutrition is put forward and details of many factors affecting birth weight are given and discussed in relation to this theory.

770* Hammond, J. Jun.

Induced Ovulation and Heat in Anoestrous Sheep.

J. Endocrinology, 1945, **4**, 169–180.

Anoestrous sheep were treated with mare serum gonadotrophin and stilboestrol and slaughtered within a week of injection ; ovaries were examined and search made for ova. All were run with a marked ram ; those treated with serum gonadotrophin only were inseminated. Others were treated with stilboestrol only, or with stilboestrol by various methods of administration at intervals before and after serum gonadotrophin administration, and were not inseminated.

All animals treated with serum gonadotrophin alone had ovulated, none of them came on heat, and none of the ova recovered was fertilized. Ovulation was induced by stilboestrol alone only in a proportion of cases, probably those having already a fair-sized follicle present. Stilboestrol is capable of inhibiting the induction of ovulation by serum gonadotrophin if given before, or too soon after, administration of the gonadotrophin.

Heat was invoked by stilboestrol, alone or in combination with serum gonadotrophin, more frequently in those animals which did not ovulate. When both heat and ovulation occurred, their timing seemed such as to render fertilization improbable ; only two fertilized ova were recovered. It appears that the interval between stilboestrol or serum gonadotrophin injection and ovulation is shorter than the latent period required in the development of heat.

There is some discussion on the bearing of these results upon prospects of commercial application to sheep breeding, upon the mechanisms involved in stimulation of ovulation and heat, and on the potential fertility of the ova obtained.

Hammond, J. Jun., Boyd, J. D. & Hamilton, W. J.

Transuterine (' Interval ') Migration of the Ovum in Sheep and other Mammals.

J. Anat. Lond. 1944, **78**, 5–14.

Data are recorded which indicate that transuterine migration is of frequent occurrence in the sheep when double pregnancy results from two ovulations in a single ovary.

The histological appearances of the uterine cornua and body in the sheep are described.

The literature on transuterine migration is summarized and discussed.

Laing, J. A.

Observations on the Survival of Stored Spermatozoa in the Genital Tract of the Mare.

J. Agric. Sci. 1943, **33**, 64–66.

Twelve pony mares were inseminated at various intervals (18 days to within 24 hr.) before ovulation with spermatozoa which had been concentrated by centrifugation and stored for 24 hr.

Of fourteen inseminations only two, both within 24 hr. of ovulation, produced pregnancies.

The survival time of the stored spermatozoa within the female tract was concluded to be somewhat less than 24 hr.

It is suggested that successful inseminations with stored spermatozoa could be made 24 hr. after the injection of prolan.

759* LAING, J. A.

Observations on the Survival Time of the Spermatozoa in the Genital Tract of the Cow and its Relation to Fertility.

J. Agric. Sci. 1945, **35**, 72–83.

Experiments were carried out to determine the period of survival of spermatozoa in the genital tract of the cow.

No reliable results were obtained by searching, *post-mortem*, the genital tracts of two cows and three heifers killed at various intervals after insemination.

An attempt to induce ovulation at a definite time to which insemination could be related, in order that the survival time of the spermatozoa might be determined by the recovery of the ova *post-mortem*, was not successful. Of four cows and one heifer given pregnant mare's serum followed by pregnancy urine, one ovulated. To one animal, where a large follicle was present in one ovary, pregnancy urine was given. Ovulation occurred but could not be definitely attributed to the pregnancy urine.

Five cows and twenty-nine heifers were inseminated with a known number of spermatozoa at various times in relation to the end of normal oestrus or oestrus induced by expression of the corpus luteum. The end of oestrus was determined by mating tests. The animals were slaughtered at such time that the ova could be recovered from the Fallopian tubes.

Inseminations made earlier than about 16 hr. before the end of heat were not fertile ; those made between 16 hr. before the end of heat and the end of heat were all fertile. After the end of heat the results were irregular. Ovulation had not occurred in seven animals slaughtered at various times from 43·5 hr. to 14 days *post-oestrum*. In one case this followed normal oestrus. The other six cases followed expression of the corpus luteum. In all six animals some luteal tissue had remained. The ova were not recovered from four other animals.

It was concluded that the period of sperm survival, under the conditions of experiment, was about 16 hr. plus the interval between the end of heat and ovulation. It is suggested that the fertility of inseminations performed soon after the end of heat depends on ovulation occurring sufficiently late for the spermatozoa to reach the ovum before it dies.

No ova were recovered with cells of the corona radiata attached

In many fertilized ova numerous spermatozoa could be seen in the zona pellucida. None were seen in unfertilized ova.

The relationship of the survival time of the spermatozoa to fertility, with special reference to different seasons of the year, is discussed.

MARSHALL, F. H. A. & HAMMOND, J. JUN.

Experimental Control of Hormone Action of the Oestrous Cycle in the Ferret.

J. Endocrinology. 1945, **4**, 159–168.

Tablets of oestrogen (either oestradiol or a diethyl-stilboestrol ester) implanted into anoestrous or oophorectomized ferrets will produce and maintain oestrus for an indefinite period.

Progesterone tablets implanted into ferrets with experimentally induced oestrus will inhibit such oestrus and on their removal oestrus will be resumed. Thus progesterone antagonizes oestrogen.

There is some evidence that intact anoestrous ferrets may be brought on heat by less implanted oestrogen than that which is required to induce heat in oophorectomized ferrets.

There is some evidence that testosterone may antagonize oestrogen in the same way as progesterone does.

The capacity for response to introduced oestrogen may vary in different ferrets and at different times in the same ferret.

Two 15mg. stilboestrol dipalmitate tablets were found regularly to be sufficient to cause swelling of the vulva ; the mean daily absorption per tablet was 4·4μg., equivalent to 1·6 g. of free stilboestrol.

MARSHALL F. H. A. & HALNAN, E. T.

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Pp. XII + 339, with 119 figs. Camb. Univ. Press, 1945. Price 18*s*.

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*785 MANN, T. **Anaerobic Metabolism of Spermatozoa.** *Nature, Lond.* 1945, **156**, 80.

ANIMAL PRODUCTION

752* CALLOW, E. H.

The Food Value of Beef from Steers and Heifers and its Relation to Dressing-Out Percentage.

J. Agric. Sci. 1944, **34**, 177–189.

An investigation has been carried out on the food value of beef from steers and heifers. A very varied group was used, selected as being representative of the beef animals slaughtered in England in war time. The animals were from five breeds ; ages varied from 1 to over 4 years, live weights from 6½ to 14 cwt. and dressing-out percentages from 50 to 62.

The chemical composition of the beef varied widely. The fat from the edible meat, expressed as a percentage of the live weight, varied from 4·6 to 21·6%, the protein from 6·1 to 7·4%, and the water from 22·8 to 27·4%. The ratio of fat to protein in the edible meat varied from 0·7 : 1 to 3·4 : 1.

Changes in the carcasses due to fattening have been expressed as straight-line equations. For every 1% increase in fatty tissue, muscular tissue fell by 0·7% and bone by 0·26%.

The data have also been expressed on a live-weight basis, because beef animals are sold by live weight. On a live-weight basis there is no significant correlation between dressing-out percentage and the percentage of muscular tissue ; nor consequently with the percentage of protein and water from the edible meat. At all dressing-out percentages about one third (31·7%) of the live weight is due to the muscular tissue of the carcass ; 6·8% of the live weight is due to the protein, and 25·5% to the water of the edible meat. A slightly higher percentage of muscular tissue (and hence of protein and water), however, is found in young light-weight animals than in old heavy-weight animals. One exception to this generalization was observed—a Welsh steer. It was considerably less fat than expectation, in spite of the fact that it was both old and heavy. This is attributed to the fact that the Welsh is a slow-growing, late-maturing breed.

The dressing-out percentage was found to depend almost entirely on the stage of fatness of the animal. For every increase of 1 in the dressing-out percentage, the fatty tissues of the carcass increased by 1·43%, the chemical fat of the edible meat by 1·47%, the dry solids (dry edible meat) by 1·45% and the edible meat itself by 1·23% ; the bone, etc., of the carcass decreased by 0·23% (all expressed as percentages of the live weight).

Equations are given which enable one to calculate, from the dressing-out percentage, the food value of the beef from steers and heifers in terms of (*a*) edible meat, (*b*) dry edible meat, (*c*) chemical fat, and (*d*) calories. An equation is also given for the ratio of fat to protein in relation to dressing-out percentage.

Tasting tests revealed that there is a close connexion between the fatness of a joint and its palatability when roasted. Up to the point at which rather more than one-third of the joint is fatty tissue, the palatability is enhanced as fatness increases. Beyond this point, the palatability diminishes. It appears that animals dressing-out at 58% provide beef at the optimum stage of fatness for maximum palatability. In peace time a value of 60 might be more appropriate.

It is shown that on the average the price of boneless beef, both in England and in America, depends upon its fat content ; the price rises as the fat content rises until a maximum price is reached at about 40% of fat. With further increases in fatness, the price falls suddenly. Price and palatability are thus affected by the fat content in a similar way.

The pre-war value of the fat and protein in English beef has been calculated. A value of 39*d*. per lb., for protein and 34·7*d*. per lb. for fat was obtained. Suet fat was worth only 12·5*d*. per lb. Fat in beef is thus worth over 2½ times more than fat removed from beef.

The official scale of prices for fat steers and heifers in war time has been examined. It is shown to be closely related to the yield of edible meat, regardless of whether the beef is lean or fat.

Methods of fixing scales of prices per live cwt. on the basis of the yield of (*a*) edible meat, (*d*) dry edible meat, and (*c*) fat and protein, are discussed and illustrated.

It is shown that the value of fat and protein separately can be calculated from any scale of prices which can be represented by the equation

$$P = b\ (\text{D.O.}) - a,$$

where P = shillings per live cwt., D.O. = dressing-out percentage, and the factors a and b are expressed in shillings.

Scales of prices per live cwt. can therefore be based on (*a*) the calculated price of fat and protein in beef, or (*b*) the calculated cost of production of fat and protein in beef animals.

778* Hammond, J. Jun. & Bhattacharya, P.
Control of Ovulation in the Cow.
J. Agric. Sci. 1944, **34**, 1–15.

Cows and heifers were injected shortly before slaughter with an extract of horse pituitary or with pregnant mare serum gonadotrophin.

These substances were administered at different times of the cycle or in pregnancy ; various doses were given simultaneously with removal of the corpus luteum.

A series of animals were given 1500 or 5000 i.u. at intervals from 5 days before to 3 days after expression of the corpus luteum ; up to thirty ovulations were so obtained.

A small number of cows have been treated and left to calve ; there have been several twin and triplet births.

The findings were discussed with a view to the mechanisms involved and to possible commercial application.

733* Hammond, J. Jun. & Day, F. T.
Oestrogen Treatment of Cattle : Induced Lactation and Other Effects.
J. Endocrinology. 1944, **4**, 53–82.

A hundred and forty cows and heifers have been given oestrogen treatment, nearly all with tablet implants of stilboestrol or hexoestrol. Observations have been made on changes in the ovaries, reproductive tract, udder and behaviour.

During treatment follicle growth ceased and occasionally the corpus luteum persisted ; after removal of the implant follicle growth began, and ovulation was resumed, sometimes after a transient period of follicular cysts. An increased frequency of double ovulations has been noted.

After the corpus luteum died out there have been irregular heats ; the frequency and intensity of these has varied greatly, in a few animals behaviour has seemed characteristically male. Relaxation of pelvic ligaments together with repeated jumping has sometimes led to fractures of the pelvis.

The heifers used were animals which had failed to get in calf—indeed, in some it was anatomically impossible. After treatment a number of those with normal organs have been served and a large proportion got in calf.

Mammary growth in heifers has occurred. Drying off of lactation, and its initiation in cows and heifers, have followed implants. In the presence of a persistent corpus luteum development of secretion is suppressed.

Lactation has not resulted in every case, and sometimes the volume of secretion is low, but many animals have given commercial yields—records are not complete, but over 130 tons of milk have been produced.

Data are given on rates of tablet absorption ; very rapid absorption within the peritoneal cavity has been observed.

There is some discussion on the possible mechanisms involved, particularly in connexion with lactation.

758* LAING, J. A.

Observations on the Effect of Method of Management at Mating on Bovine Fertility.

J. Agric. Sci. 1945, **35**, 25–29.

The fertility records of two groups of bulls, one group used for controlled service, and one group used for free service, were compared over a period of one year.

The fertility of the free-service group was consistently better except during the months of December, January, February and March.

The difference in fertility between the two groups was correlated with the varying length of the oestral periods of the cows at different seasons of the year.

It is suggested that the higher fertility in the free-service group was due to a closer relationship of service to the end of heat and thus to ovulation.

PALMER, N.

An Account of a Recent Investigation of Wool Growth.

Rep. Proc. Brit. Soc. Anim. Prod. 1944, **2**, 62–63.

Wool growth throughout the year has been sampled from tattooed regions of the skin. The growth of wool is affected by the follicle density at birth, the rate of skin expansion and environmental conditions.

WALLACE, L. R.

Feeding during Pregnancy.

Rep. Proc. Brit. Soc. Anim. Prod. 1944, **2**, 58–61.

The effect of the level of feeding during pregnancy on (*a*) birth weight of the lamb, (*b*) the volume of milk produced during the lactation period, and (*c*) the rate of growth of the lamb, was determined. It was shown that the plane of feeding during the last four weeks of pregnancy is of paramount importance for all these three characters. In a series of ewes slaughtered a few days before the time for parturition, it was found that the growth of the udder tissue was greatly influenced by the plane of nutrition during the last four weeks of pregnancy.

OTHER PAPERS

820* HAMMOND, J. **'Constitution' in Cattle in Relation to Pests and Diseases.** *Ann. Appl. Biol.* 1945, **32**, 278.

806* HAMMOND, J. **Effect of the Plane of Nutrition on Growth and Development.** *Biology.* Autumn, 1942.

717* HAMMOND, J. **Improved Breeding for Milk Production.** *Agriculture : J. Minist. Agric.* 1943, **50**, 242–245.

731* HAMMOND, J. **The Improvement of Cattle.** *Bath W. S. Co. Ass. Pamphl. No.* 12, 1944.

771* HAMMOND, J. JUN. **Correction for Time of Service in Lactation Records for a Fixed Period.** *Emp. J. Exp. Agric.* 1944. **12**, 154–156.

MANSFIELD, W. S. **Calf-Rearing by Natural Methods.** *Agriculture : J. Minist. Agri.* 1945, **51**, 481–483.

MANSFIELD, W. S. & BROOKES, A. J. **Grading-up a Herd of Non-Pedigree Cows.** Contribution to *The Dairy Shorthorn, Its Use in Grading Up Commercial Herds.* Pp. 1–7. Shorthorn Soc., London.

FORESTRY

THOMPSON, C. H.

Post-War Forestry. Implications of the Dedication Scheme.

Estate Mag. 1945, **45**, 85–88.

An outline is given of the Forestry Commission's proposals for the Scheme, followed by notes on the preparation of the Working Schemes demanded. Lastly, a form of co-operative management by neighbouring owners as the means of bringing the majority of woodlands on the smaller states under dedication is suggested

PLANT BREEDING AND GENETICS

BELL, G. D. H.

The Breeding of Two-Row Winter-Hardy Barley.

J. Agric. Sci. 1944, **34**, 223–238.

The more extended cultivation of the barley crop is dependent on the production of new varieties suitable for cultivation under conditions to which existent varieties cannot successfully be applied. One of the ways in which successful barley cultivation can be extended is by the development of winter-hardy types which mature earlier than spring sown varieties, and which spread the labours of sowing and harvesting in intensive barley growing areas.

The characters which determine winter-hardiness, and the association of other plant attributes with winter-hardiness are most important for research involving breeding improved winter-hardy forms, and the necessity for understanding the relationship between winter-hardiness and the growing conditions are discussed.

The basis of the breeding work at Cambridge was hybridization between low yielding, poor quality winter-hardy varieties with high yielding, good quality spring varieties. The most successful cross was Tschermak's two-row x Spratt-Archer, and as a result of selection in the field over six years, including two severe winters, satisfactory cultures were obtained which combined winter-hardiness with high yield and desirable field characters and satisfactory quality. The best of these cultures was put on the market in 1943 under the name of Pioneer.

BELL, G. D. H.

Crops and Plant Breeding.

J. R. Agric. Soc. 1943, **104**, 8–17.

This deals first with the most efficient use of the agricultural land of this country and the need for adequate planning of systems of crop husbandry. Special reference is made to the utilization of the upland areas, and their integration into a permanent agricultural policy for the country. In lowland areas the development of new rotations based on alternate husbandry, the extended use of little grown crops, and the more efficient cultivation of improved varieties and strains of crop plants are discussed.

The relationship between yield and quality in hay and grass, potatoes, cereals, sugar beet and mangolds is then considered. It is stated that productivity cannot be measured in terms of bulk only, but the question of quality should be given more serious attention. There is a tendency in growing to concentrate on high yields regardless of the quality of the product.

BELL, G. D. H.

Crops and Plant Breeding.

J. R. Agric. Soc. 1944, **105**, 1–12.

The need for adequate education and the full use of the results of research for the development of the most intensive agricultural production are stressed. The development of ley farming and the relationship between arable land and grassland in different parts of the country are then discussed, and consideration is given to planned rotational systems of cropping under different growing conditions.

The second section of this article deals principally with seeds mixtures and the use of different strains of herbage plants, with reference also to the question of seed production and the activities of the special Government Committee which has been set up to control supply. The problem of teartness of pastures is also discussed briefly.

Manganese deficiency and the susceptibility of cereal varieties to this condition, the effect of fallowing on the yield of wheat and barley, and the breeding of a new variety of malting barley which shows a high degree of winter hardiness are the subjects dealt with in the concluding section on cereals.

750* CARSON, G. P. & HOWARD, H. W.

Inheritance of the ' Bolter ' Condition in the Potato.

Nature, Lond. 1944, **154**, 829.

Comparing the cross Gladstone x Flourball with Gladstone bolter x Flourball, it was found that the latter contained a much higher percentage of seedlings with ' wild root ' systems.

755* CARSON, G. P. & HOWARD, H. W.

Note on the Inheritance of the King Edward Type of Colour in Potatoes.

J. Genet. 1945, **46**, 358–60.

The varieties of King Edward and Gladstone are simplex for the gene K which produces localized areas of red pigment in the periderm and nulliplex for the gene R which produces uniform red pigmentation in the outer layers of the cortex. Flourball is nulliplex for K and simplex for R.

HAWKES, J. G.

The Indigenous American Potatoes and Their Value in Plant Breeding.
I. Resistance to Disease. II. Physiological Properties, Chemical Composition, and Breeding Capabilities.

Emp. J. Exp. Agric. 1945, **13**, 11–40.

The various uses to which the indigenous American potatoes have been put are described, and the lines of research which might prove valuable in the future outlined. Probably the most useful wild species are to be found in the series *Acaulia, Demissa* and *Longipedicellata*. *S. demissum*, in particular, has proved to be of all-round value, both because of its resistance to blight, Colorado beetle and frost, and also because of its fertility when selfed and crossed with the tetraploid *S. andigenum* and *S. tuberosum*. The high proportion of wild-type and undesirable characters however necessitates a very large number of hybrid generations, either by selfing or back-crossing with a variety of *S. tuberosum* or *S. andigenum*, before economically useful varieties are obtained.

S. andigenum, the most promising cultivated species, possesses high vigour, yield, protein, vitamin C and starch content, together with a greater range of flavour and cooking qualities than the ordinary European domestic potato. In contrast to the European potato, it is also highly fertile. There is no doubt that it could be used advantageously in most breeding programmes in addition to the wild species. Possibly in some parts of the empire *S. andigenum* might even supplant *S. tuberosum* in contributing factors for yield and tuber quality.

The author suggests that the building up of certain hybrid stocks would be of great advantage to the breeder, using as a basis some of the most economically important wild and native cultivated species and incorporating all the necessary qualities of disease resistance with moderate yield and high fertility. Much time would thus be saved. In problems that have hardly been touched, such as eel-worm immunity in Great Britain, the need for a thorough survey of the indigenous American potato is emphasized.

The sytematic classification and geographical distribution of the native American potatoes is also discussed with special reference to the work of the Empire Potato Collection of the Imperial Agricultural Bureaux at Cambridge, and the fertility of the various species and the results that have been obtained in interspecific crosses are briefly described.

HAWKES, J. G.

Potato Collecting Expeditions in Mexico and South America. II. Systematic Classification of the Collections.

Imp. Bur. Plant Breed. Genet., 1944. Pp. 141. Price 7*s.* 6*d.*

This second bulletin on the Imperial Agricultural Bureaux Potato Collecting Expeditions deals primarily with the classification and naming of the specimens obtained. The bulletin is divided into six sections and carries three appendices.

The first two sections embody an introduction and a short historical survey of potato taxonomy. In the third section is found a general account of the botanical classification of potato species from the time of Dunal down to the present day. Embodied in this section is a dichotomous key to the various series within subsection *Hyperbasarthrum*, the portion of the genus *Solanum* to which all potatoes belong. The phylogenetic relationships of the series are then discussed, and a map showing the recorded localities of all the wild species with an indication of those collected by the expeditions is given.

Section 4 deals with the taxonomy of the specimens collected by the expeditions. The descriptions of specimens not brought back in the living state and hence of no use to plant breeders are included here, though in smaller type, in order to present a complete and scientific account of the work done, and for the benefit of future expeditions. Some 30 new wild species and five new cultivated species are described, together with one new series. Where previously known species are dealt with, a certain amount of taxonomic and phylogenetic information is included where it has been thought necessary to clarify the situation or bring together certain obscure and previously isolated facts.

Section 5 gives an account of the cytological investigations on the collection. The somatic chromosome number of over 900 samples was determined the results being embodied in the previous section on systematics. The relationship between systematic and geographical grouping and chromosome number in the different species is discussed, and the probable lines of evolution in the polyploid series of both wild and cultivated species are indicated.

The sixth section deals with the several theories on the origin and evolution of potatoes. An examination of the historical evidence for the antiquity of agriculture based on the potato leads the author to conclude that this plant was first cultivated in the region of S. Peru—N. Bolivia. This is followed by a discussion on the lack of indigenous potato cultivation in Mexico. An enquiry into the different types of weed and semi-cultivated potatoes is shown to throw some light on the types of potatoes that were first cultivated and their subsequent development. The probable relationships of the different cultivated species are discussed and the importance of the role played by man in their distribution is emphasized. The two tetraploid species *S. andigenum* and *S. tuberosum* s. str. are considered to have had a common origin in the Peru-Bolivian region and not as formed each from distinct wild species as the Russian investigators have suggested.

The final portion of this section deals with the various theories for the origin of the European potato. Evidence is presented from historical, geographical, morphological and photoperiodic points of view to show that the first introductions of potatoes came from the Andes, most probably Colombia, and not, as has so often been supposed, from Chile.

The first two appendices give the Latin descriptions and complete list with chromosome numbers respectively of the new species and varieties. The third appendix gives a complete list of identifications of the Empire Potato Collection.

808* HAWKES, J. G.

The Story of the Potato.

Discovery. 1945, 38–46.

A popular account is given of the origin and introduction of the potato into cultivation and of the species existing at the present time. It is concluded that the domestic potato arose from *Solanum andigenum* introduced into Europe between 1570 and 1590, two separate introductions having been made.

749* HOWARD, H. W.

Heredity, Development and Infection.

Nature, Lond. 1944, **154**, 778.

A reply to a letter by Prof. J. B. S. Haldane. It is suggested that British geneticists have not been able to confirm the genetical work of the Lysenko School.

713* HOWARD, H. W.
Heteroauxin and the Production of Tetraploid Shoots by the Callus Method in *Brassica oleracea*.
J. Genet. 1942, **44**, 1–9.

Callus shoots obtained by decapitation only and by decapitation plus heteroauxin treatment both contained about 10% of tetraploids. The origin of callus buds is considered.

OTHER PAPERS

HUNTER, H. **Certification of Cereals.** *Agriculture : J. Minist. Agric.* 1944, **51**, 262–263.

HUNTER, H. **The Improvement of Malting Barleys, in Retrospect and Prospect.** *J. Inst. Brew.* 1943, **49**, 296–302.

HUNTER, H. **Winter Hardiness in Cereals.** *J. R. Agric. Soc.* 1941, **101**, 28–36.

PLANT NUTRITION

712* WOODMAN, R. M.
The Nutrition of the Carrot.
Ann. Appl. Biol. 1943, **30**, 1–7.

In sand-culture experiments with carrots, it was shown that a moderate quantity only of nitrogen was necessary for optimum growth compared with, for example, the turnip root. A moderate amount of (available) phosphorus was also sufficient for this purpose, as with the turnip, but contrary to experience with lettuce roots and tops. The greatest concentration of potassium applied, however, was probably the best for root development. Deficiency of phosphorus caused bronzing of the leaves, and absence of potassium, serious scorch ; absence of boron resulted in a small, immature plant. Initial field trials on an old river gravel during experiments throughout the last 7 years indicated that dung gave no advantage over artificials, that artificials were possibly not needed on dunged land or land in good heart, and that land out of good heart, undunged and unfertilized throughout the 7 years, responded well to artificials, particularly phosphate and potash. The incidence of carrot fly, according to preliminary experiments, seemed to depend greatly on the nutrition of the carrots.

716* WOODMAN, R. M.
Nitrogen Nutrition of the Onion.
Ann. Appl. Biol. 1943, **30**, 116–117.

Culture experiments with onions in sand demonstrated that the best range of concentrations of nitrogen for production of bulbs is 16·48—32·96 p.p.m., concentrations above or below this range leading to reduced yields.

728* WOODMAN, R. M.
The Nutrition of the Pea.
Ann. Appl. Biol. 1944, **31**, 19–22.

Sand-culture experiments with the pea plant demonstrated that 8·24—32·96 p.p.m. of available nitrogen was the optimum range of concentrations for yield of peas, with a bias in favour of the lower half of the range ; adequate supplies of nitrogen appeared to cause branching of the tops into two or more main stems. The best range of concentrations of available phosphorus was 2·73—10·92 p.p.m., while that for available potassium was 5·61—44·88 p.p.m. Deficiency of potassium caused marginal scorch followed by general scorch and death of the foliage progressively up the stem. Absence of boron had not a great effect with this plant, probably because the large seed possibly contains an appreciable amount of boron.

726* WOODMAN, R. M.
The Nutrition of the Radish.
Ann. Appl. Biol. 1943, **30**, 319–322.

Sand-culture experiments with the radish demonstrated that the optimum concentrations of nitrogen for root development were the highest employed, 32·96 and 65·92 p.p.m. Deficiency of nitrogen led to poor growth and to a characteristic outlining of the cotyledons in red, with red petioles. As with the carrot and turnip, a low concentration of available phosphorus, here 2·05—4·09 p.p.m., gave the best root growth ; and a marketable radish was obtained with so little as 0·10 p.p.m., suggesting that the relatively large radish seed contains a considerable quantity of phosphorus. The highest concentration of potassium used, 22·44 p.p.m., yielded the largest roots, and a diminution in this amount led to loss of yield and eventually to serious scorch of the foliage. There is possibly some boron in the radish seed ; for though absence of this from an otherwise satisfactory solution resulted in diminished yields, the foliage was normal in appearance, and the radish of eatable size ; the radishes apparently lacked ability to swell.

729* WOODMAN, R. M.
The Nutrition of Vegetables in Sand.
Ann. Appl. Biol. 1944, **31**, 22–30.

The yield data available from the author's series of investigations on vegetable nutrition in sand have been plotted against the concentrations of the elements concerned (nitrogen, phosphorus and potassium), and the curves so obtained have been discussed. Within the ranges of concentrations employed, it is observed that too much available nitrogen or, especially, available phosphorus, causes depressions in yields with the tops and/or roots of certain vegetables, turnip roots being particularly susceptible to too much available phosphorus ; no case of over-employment of available potassium, however, is noted. The turnip is recommended as a type plant for indicating the state of and fertility as regards available (nitric) nitrogen.

730* Woodman, R. M., & Paver, H.
The Effect of Time of Application of Inorganic Nitrogen on the Turnip.
J. Agric. Sci. 1944, **34,** 49–56.

An investigation has been made into the effect of time of application of nitrogen as sodium nitrate to the turnip. Experiments were arranged on a statistical basis, and were carried out in sand culture. The life of the turnip up to harvest was arbitrarily divided into three equal light periods, and the fourteen possible combinations of high and low nitrogen applied in these periods constituted the treatments. The absolute amount of growth was largely determined by the level of nitrogen, but the relative proportion of growth was independent of this level. Tops developed earlier than roots, and the effect of difference in nitrogen level was more marked with the roots than the tops. For a high yield of roots it seems desirable to apply nitrogen early, but for a high yield of tops it would be preferable to apply the nitrogen as post-seedling dressings. The chief effect of level of nitrogen on moisture content was confined to the period in which the harvest took place. A comparison of top/root ratios also showed that high nitrogen in the early stages of growth stimulated root development.

753* Woodman, R. M., & Paver, H.
The Nutrition of the Carrot. II. Grown in a Fen Soil.
J. Agric. Sci. 1945, **35,** 30–32.

Carrots of Chantenay type were grown in cultures of a black fen soil shown by analysis to be deficient in phosphate but normal as regards potash. When phosphate was absent, the cotyledons, and sometimes the whole of the foliage, were dark bronze in colour. There was a statistically significant increase in yield following applications of phosphate, but a tendency for applied nitrogen and potash to diminish yield.

734* Woodman, R. M., & Johnson, D. A.
The Response of the Carrot to Water Supply and Fertilizer on a Gravel Soil.
J. Agric. Sci. 1944, **34,** 82–87.

An experiment designed to show the effects of a complete fertilizer and of water applied extra to the rainfall on the yield of carrots grown on a gravel soil in good heart, has demonstrated that the fertilizer mixture was entirely without effect. The interaction water level × fertilizer was not significant, so that the increases in yield of carrot roots (increases which were 61·46 and 127·5% above the mean of the plots for rainfall only in the case of the total crop, and 61·73 and 111·5% for ware carrots, for 3 and 6 in. of water extra to the rainfall, respectively) were due entirely to the additional water. The response in yield of the roots of the total crop and of ware to the second application of extra water showed no falling off compared with the response to the first extra application. There was evidence to prove that additional water caused heavier infestation of the roots by aphis.

PLANT PATHOLOGY

Carson, G. P., Howard, H. W., Markham, R., & Smith, K. M.
Paracrinkle Virus and Inheritance.
Nature, Lond. 1944, **154,** 334.

A criticism of part of an article by Dr. C. D. Darlington. It is pointed out that the paracrinkle virus of the potato variety King Edward is not transmitted to seedlings in the cross King Edward female x Flourball and that other potato varieties such as President are symptomless carriers of paracrinkle.

Lea, D. & Smith, K. M.
The Inactivation of Plant Viruses by Radiation.
Parasitology. 1940, **32,** 405–415.

Experiments in the inactivation of various plant virus preparations by ultra-violet light and by X-rays are described. The curves obtained by plotting against the dose of radiation the number of lesions obtained in inoculation of a test plant are exponential and the rate of inactivation is proportional to the intensity of the radiation. The inactivation curves obtained with preparations of a given virus in different states of aggregation do not appear to be systematically different.

The discussion of these results shows that the particles in an aggregated virus suspension cannot be considered to be permanent clusters of elementary virus particles. Two possible alternatives which are compatible with the radiation experiments are discussed, either (*a*) the aggregation consists of the attachment of a single elementary virus particle to inert matter, or (*b*) the aggregation consists of a reversible union of elementary particles which are constantly aggregating. The dose of X-radiation required for inactivation of the virus is consistent with the view that inactivation is caused by the production of a single ionization in the elementary virus particle, the size of which is approximately known from infiltration experiments.

Lea, D. & Smith, K. M.
The Inactivation of Plant Viruses by Radiations. II.
The Relation Between Inactivation Dose and Size of Virus.
Parasitology. 1942, **34,** 227–237.

Experiments are described on the inactivation by gamma-rays, X-rays, and alpha-rays of the viruses of tomato bushy stunt, tobacco necrosis, tobacco ringspot, tobacco mosaic and potato virus X. Within the errors of the experiment the inactivation curves appear to be exponential, and the inactivation doses increase in the order gamma-rays, X-rays of wave-length 1·5 A., X-rays of wave-length 8·3 A., and alpha-rays.

A theory is given explaining these results and correlating the inactivation dose with the virus size. Estimates of the sizes of the viruses obtained from the radiation experiments lie within the range of the sizes given by other methods, but are somewhat lower than the most probable sizes. Possible explanations of the discrepancy which are discussed are (*a*) the virus particle is not the molecule, in the sense of the smallest infective unit, or (*b*) certain structural changes in the virus molecule produced by the radiation may still leave it infective. Some of these may perhaps show themselves as mutations.

LEA, D., SMITH, K. M., HOLMES, B. & MARKHAM, R.

Direct and Indirect Actions of Radiation on Viruses and Enzymes.

Parasitology. 1944, **36**, 110–118.

The inactivation by *y*-rays of tobacco mosaic virus is studied at various concentrations. It is found that the inactivation dose is independent of concentration at high concentrations, and at low concentrations also attains a constant, but lower, value. Over an intermediate range the inactivation dose increases with increase of concentration.

These facts are explained on the basis that when irradiated dry or in concentrated solution the inactivation is direct and due to ionization produced inside the virus particle. At lower concentrations the inactivation is largely indirect and due to ionization of the water.

Gelatin added to the solution protects the virus against the indirect action of radiation.

Curves are given of the inactivation of dry preparations of ribonuclease and adenylpyrophosphatase (myosin) by X-rays.

It is shown that on the assumption that a single ionization in an enzyme molecule leads to its inactivation, measurement of the inactivation dose leads to a rough estimate of the molecule weight of the enzyme.

There appears to be no fundamental difference in the mechanism of radiation-inactivation of viruses and enzymes.

793* MARKHAM, R.

The Isolation of Viruses by Means of the Electrically Driven Sharples Supercentrifuge.

Parasitology. 1944, **35**, 173–177.

The use of an electrically driven Sharples supercentrifuge for isolating viruses is described. The theory of sedimentation in such centrifuges is discussed and curves of the theoretical minimum sedimentation rates are given. The probability that conversionless sedimentation cannot take place in high-speed preparative centrifuges is discussed in relation to the theory of ' differential centrifugation '.

SMITH. K. M.

Black Ring Disease of the Tomato.

Gdnrs' Chron. 21 April, 1945.

A description of a new virus.

SMITH, K. M.

A Further Note on the Viruses Affecting *Atropa Belladonna* **and a Description of a Virus Complex Attacking** *Hyoscyamus niger*.

Parasitology. 1945, **36**, 209–210.

It has been shown that *Atropa belladonna* acts as a symptomless carrier of *Hyoscyamus Virus I*. Some symptoms caused by this virus or other solanaceous plants are described.

A naturally occurring virus complex in *Hyoscyamus niger* was found to consist of *Solanum Virus I* (potato virus X) and *Brassica Virus I*. During the course of investigations it was found that potato virus X forms local lesions on the cotyledons of ridge cucumber without systematic infection and that *Brassica Virus I* behaves similarly on the inoculated leaves of *Nicotiana sylvestris*.

SMITH, K. M.

Studies on the Spread of Certain Plant Viruses in the Field.

Ann. Appl. Biol. 1943, **30**, 345–348.

Studies on the spread of potato viruses X and Y and cucumber mosaic virus in the field are described : tobacco was used as the experimental plant. The plants were set out in the form of a cross, one series with the leaves in contact and one with the leaves not touching. No spread of potato virus X was observed, but there was extremely rapid permeation of virus Y throughout the plots. The spread of cucumber mosaic virus was much slower than that of virus Y.

SMITH, K. M.

Transmission by Insects of a Plant Virus Complex.

Nature, Lond. 1945, **155**, 174.

Description of an interesting phenomenon in which one virus is only insect-transmitted if a second virus is also present in the plant.

SMITH, K. M.

A Virus Disease of *Atropa belladonna*.

Parasitology. 1943, **35**, 159–160.

A virus disease of *Atropa belladonna* caused by a new virus is described. The virus is sap-transmissible to tobacco and other solanaceous plants and gives good local lesions on *Nicotiana glutinosa* and *Phaseolus vulgaris*. It occurs in fairly high concentration in the plant, it withstands ageing in extracted sap for 6 to 11 days, and is inactivated at a temperature between 75 and 80°C.

SMITH, K. M.

Some Notes on the Relationship of Plant Viruses with Vector and Non-Vector Insects.

Parasitology. 1941, **33**, 110–116.

Extracts of caterpillars and other insects are shown to inhibit the infective power of tobacco mosaic and tobacco necrosis viruses. The inhibitor is not sedimented after spinning for 2½ hr. at 30,000 r.p.m. Experiments with non-vector insects such as caterpillars have shown that the virus of sugar-beet curly-top, of tobacco ringspot and other viruses, are destroyed within the body of the insect. On the other hand, tobacco mosaic virus passes through the body of the caterpillar unchanged though greatly reduced in concentration. By the use of the specific insect vector and artificial feeding methods it was possible to recover the virus of curly-top 24 hr. after it had been injected into the blood of the caterpillar but the viruses of tobacco mosaic and tobacco necrosis could not be so recovered. Experimental evidence is given below to show that the virus of beet curly-top is present in the saliva of viruliferous insects.

SMITH, K. M. & MARKHAM, R.

Two New Viruses Affecting Tobacco and Other Plants.

Phytopathology. 1944, **34**, 324–329.

Two new viruses affecting tobacco and other plants are described. One was first observed in a plant of *Arabis hirsuta* and the other in tobacco. Both viruses produce diseases of the ringspot type in tobacco, but the virus from *Arabis* can be distinguished easily by the fact that it induces a characteristic curling and shredding of the central leaves.

The main points of interest concerning these two viruses are their origin and their methods of spread. Both viruses are new and both appeared in plants that were growing inside the insect-proof glasshouse. Moreover, the disease caused in the *Arabis* plant first appeared in mid-winter. The appearance of these viruses certainly needs some explanation, since they are very uninfectious and no insect vector has been discovered. In consequence, there is no information on their natural mode of spread. Indeed, the viruses would have been lost with the death of the original plants in which they appeared had it not been that they were carefully propagated by mechanical methods of inoculation.

SMITH, K. M. & MARKHAM, R.

A Virus Disease of Lovage (*Ligusticum scoticum*).

Phytopathology. 1944, **34**, 335–340.

A new virus affecting lovage (*Ligusticum scoticum L.*) is described. The host range, so far as tested, seems wide and includes plants in the Solanaceae, Umbelliferae, Leguminosae, Cucurbitaceae, Malvaceae and Cruciferae. The virus is sap-transmissible but its natural means of spread are not known. It is inactivated by a 10-minute exposure to a temperature of 60°C. The infectivity of juice from diseased plants is low.

763* TAYLOR, R. E. & WESTON, W. A. R. D.

Seed Disinfection. VI. Stripe Smut of Rye.

J. Agric. Sci. 1945, **35**, 116–118.

An account is given of the distribution of Stripe Smut (*Urocystis occulta*). Experiments show that seed-borne infection is effectively controlled by seed disinfection, but that the disease is also soil borne.

WESTON, W. A. R. D.

Diseases of Corn Crops.

Agriculture : J. Minist. Agric. 1944, **50**, 496–499.

A review of cereal diseases in 1943. Mildew (*Erysiphe graminis*), was severe on barley, and Yellow Rust (*Puccinia glumarum*) on wheat. The resistance of different wheat varieties to this rust is discussed. Take-all (*Ophiobolus graminis*) was prevalent though not severe. Oats in East Anglia appear immune to this disease, but a strain of *O. graminis* which attacks oats is found in Northern England and Scotland. Suggestions are made for obtaining the maximum yields from cereal crops.

767* WESTON, W. A. R. D.

Diseases of Field Beans.

Agric. Progr. 1945, **20**, 31–35.

A survey of Chocolate Spot and Bean Rot with special reference to weather conditions, which predispose the crop to disease. No way of preventing Chocolate Spot (*Botrytis cinerea*) attacks had been found and seed disinfection does not improve growth or yields. Bean Rot is due to a form of the same fungus which causes Clover Rot (*Sclerotinia Trifoliorum*). Land becomes contaminated by sclerotia formed on the diseased plants. Crops grown on land that has not previously carried a bean or clover crop may become infected by wind-borne ascospores or from sclerotia carried onto the land in dung. Farmers troubled with bean- or clover-'sick' land are advised not to grow susceptible crops on it for at least eight years.

766* Weston, W. A. R. D.

Looking Back and Looking Forward—A Retrospect of Cereal Diseases in E. Anglia in the Past 21 Years.

Ann. Appl. Biol. 1944, **31**, 366–370.

In this survey, although observations are recorded on the prevalence and intensity of the principal cereal diseases in East Anglia, the author is concerned primarily with seed-borne diseases and their control by methods of seed disinfection.

He discusses the progress of seed disinfection over the past 21 years and notes three important phases. First the tentative use on the Cambridge University Farm in 1925 of a machine for dusting seed wheat with a basic copper carbonate powder to prevent bunt in wheat, second the introduction in 1929–30 of a proprietary organo-mercury seed dressing for the disinfecting of all seed corn, and third the instigation in 1943 of an official scheme for approving certain proprietary organo-mercury seed dressings.

From field experiments conducted over a number of years he concludes that there are variations in the effectiveness of the various proprietary organo-mercury seed dressings and he states that, if the approval scheme is to maintain the high prestige which it deserves then (1) the standard of efficiency must be very jealousy guarded, and (2) it may be desirable to assess this standard by field trials, as the intrinsic test of a seed dressing is its performance in the field.

Weston, W. A. R. D.

Seed Disinfection of Barley and Oats.

Agriculture : J. Minist. Agric. 1942, **49**, 157–160.

A semi-popular description of the symptoms of *Helminthosporium avenae* and *H. gramineum* on oats and barley, with recommendations for their control by the use of an organo-mercury seed dressing. In recent experiments six proprietary organo-mercury seed disinfectants were tested for control of *H. gramineum* on barley (98% natural infection). In the treated plots there was less than 0·4% of seedlings affected with stripe as against 34% in the untreated plots. Seed treated with formalin showed 29% infection.

715* Weston, W. A. R. D. & Garrett, S. D.

Rhizoctonia Associated with a Root Rot of Cereals in Norfolk.

Ann. Appl. Biol. 1943, **30**, 79.

In 1938 several cereal crops (especially barley) were a partial failure in Norfolk. Shortly after growth had started, or had been resumed in the spring, well defined patches of stunted plants were observed (sometimes ¼ acre in extent). Most of the plants in these patches were generally dead or dying by mid-June. The roots of affected plants showed the presence of *Rhizoctonia* (*Corticium*) *Solani*. The diagnosis was confirmed by isolation and pathogenicity tests. The disease, recorded from seven farms in Norfolk, is at present only of minor importance.

768* Weston, W. A. R. D. & Smith, K. M.

Crop Diseases and Their Control.

J. R. Agric. Soc. 1944, **105**, 125–132.

A popular description of some well-known seed, soil and air-borne cereal diseases, and the virus diseases affecting potatoes, sugar beet and crucifers. Appropriate control measures are suggested.

764* Weston, W. A. R. D. & Taylor, R. E.

An Abnormal Growth of Mushrooms.

Trans. Brit. Mycol. Soc. 1943, **26**, 144–145.

An account of an abnormal growth on a cultivated mushroom similar to that described for " rose-comb " disease.

762* Weston, W. A. R. D. & Taylor, R. E.

Blight.

Agriculture : J. Minist. Agric. 1944, **51**, 111–116.

A practical discussion of the control of Potato Blight (*Phytophthora infestans*) and a review of the disease throughout the war.

811* Weston, W. A. R. D. & Taylor, R. E.

Development of Mould on the Cut Surfaces of Potato Tubers.

J. Agric. Sci. 1944, **34**, 93–96.

Cut potato tissue possesses strong inherent powers of healing which are impaired by treatment with salts of copper, cobalt, nickel and iron. Treatment is followed by mould growth, particularly by *Penicillium* spp., this being most profuse with copper salts and least with those of iron.

Association between mould growth and treatment with the above salts suggest a periodic relationship.

Development of *Penicillium* on potato tissues following treatment with salts of copper is greater than may be explained solely on the basis of saprophytic growth following phytocidal action and the prevention of suberization.

Under moist conditions, treatment of non-living substrata (straw, leather and skin) with copper sulphate tends to prevent mould growth, whilst considerable growth develops on these materials when untreated.

709* Weston, W. A. R. D. & Taylor, R. E.
Development of Penicillium on the Cut Surfaces of Certain Vegetables.
Nature, Lond. 1943, **151**, 54.
A preliminary account of the development of moulds (especially *Penicillium* spp.) on the cut surfaces of potato tubers after treatment with certain salts, particularly those of copper, cobalt, nickel and iron. A detailed account of these observations is published in the *J. Agric. Sci.* **34**, 93–96.

708* Weston, W. A. R. D. & Taylor, R. E.
Observations on Ergot in Cereal Crops.
J. Agric. Sci. 1942, **32**, 457–464.
Examination of records of Ergot (*Claviceps purpurea*) on cereals during the past 24 years show that the fungus is most common on rye, less so on wheat and barley, and rare on oats. Between 1939 and 1942 the disease was most prevalent in the north, and rare in Suffolk and Norfolk in 1942. The percentage by weight of ergot in the threshed grain of the contaminated barley crops examined ranged from 0·03–0·88 ; the alkaloidal content of one sample was assayed. A method is described for freeing grain from ergot. Barley is pre-soaked in water, which is then replaced by a solution of sodium chloride or potassium chloride. The ergots float to the surface and can be removed by skimming. Sodium chloride treatment increased germination, while potassium chloride slightly reduced it.

765* Weston, W. A. R. D. & Taylor, R. E.
Some Observations on Powdery Mildew.
Trans. Brit. Mycol. Soc. 1944, **27**, 119–120.
The overwintering of *Podosphaera leucotricha, Microsphaera alni-var extensa* and *Sphaerotheca pannosa* is discussed. Observations are made on *P. oxyacanthae, S. pannosa* and *S. mors-uvae* in an old Cambridge garden. It is suggested that a study should be made to discover whether these mildews perennate wholly or partly by dormant mycelium in the bud.

707* Weston, W. A. R. D. & Taylor, R. E.
Seed Disinfection. V. Stripe Diseases of Barley and Oat.
J. Agric. Sci. 1943, **33**, 23–27.
The O.S.T.S. (Cambridge) figures show that there has been no reduction over the past 20 years in the number of samples of barley and oats affected with *Helminthosporium*, and no reduction in the intensity of seedling diseases from the same cause was noted for the first 10 years of the period. Seed treatment with formalin or copper carbonate was not effective in controlling this disease, and copper sulphate, although partially effective had a serious phytocidal effect. Since the advent of organo-mercury seed disinfectants there has been an improvement in the control of the disease and field tests show that these dressings are most satisfactory. Barley straw, infected with *H. gramineum* has been shown to be a source of secondary infection of barley seedlings.

761* Weston, W. A. R. D. & Taylor, R. E.
Stripe Smut of Rye.
Nature, Lond. 1943, **152**, 160.
Stripe Smut (*Urocystis occulta*) of rye has been observed recently on several occasions in Norfolk ; 80 acres from one farm being moderately infected. The disease is rare in Great Britain, and has not been observed in East Anglia during the past 20 years, though it has been recorded at Rothamsted in 1932, Romsey, Hants. in 1920 and Askham Bryan, Yorks. in 1936. It can be controlled by using an organo-mercury seed dressing, but as it is soil-borne, rye must not be grown on the same land as a crop that had the disease in the previous season.

OTHER PAPERS

Kvíčala, B. **Selective Power in Virus Transmission Exhibited by an Aphis.** *Nature, Lond.* 1945, **155**, 174.

Markham, R. **Biochemistry. 3. Viruses.** *Annu. Rep. Chem. Soc.* 1943, **40**, 197–203.

Markham, R., Smith, K. M. & Lea, D. **Note on the Size of the Shope Rabbit Papilloma Virus.** *Parasitology.* 1944. **35**, 178–179.

Markham, R., Smith, K. M. & Lea, D. **The Sizes of Viruses and the Methods Employed in Their Estimation.** *Parasitology.* 1942, **34**, 316–352.

Smith, K. M. **Dahlias and the Problem of Virus Infection.** *Gdnrs' Chron.* 29 September, 1945.

Smith, K. M. **Molecule or Organism ?** *Discovery.* 1944, 170–172.

Smith, K. M. **Plant Viruses.** *Endeavour.* 1945. **4**, 22–28.

Smith, K. M. **Some Practical Difficulties in the Production of Virus-Free Seed Potatoes.** *Ann. Appl. Biol.* 1943, **30**, 84–85.

Smith, K. M. **The Virus Diseases of Dahlias and Their Control.** *Brit. Dahlia Gr. Ass.* 1945.

Smith, K. M. **Viruses and Insects.** *Discovery.* 1943, 338–341.

Smith, K. M. & Markham, R. **Importance of Potato Virus X in the Growing of Potatoes.** *Nature, Lond.* 1945, **155**, 38.

745* Weston, W. A. R. D. **American Gooseberry Mildew.** *Agriculture : J. Minist. Agric.* 1945, **52**, 71–72.

746* WESTON, W. A. R. D. **Brown Rot in Apples.** *Agriculture :* 1945, **52,** 135–137.

737* WESTON, W. A. R. D. **Bunt of Wheat.** *Agriculture : J. Minist. Agric.* 1944, **51,** 264–265.

738* WESTON, W. A. R. D. **Chocolate Spot of Beans.** *Agriculture : J. Minist. Agric.* 1944, **51,** 325–326.

740* WESTON, W. A. R. D. **Clover Rot.** *Agriculture : J. Minist. Agric.* 1944, **51,** 349–350.

739* WESTON, W. A. R. D. **Club Root Disease.** *Agriculture : J. Minist. Agric.* 1944, **51,** 420–422.

741* WESTON, W. A. R. D. **Downy Mildew of Sugar Beet.** *Agriculture : J. Minist. Agric.* 1944, **51,** 468–470.

WESTON, W. A. R. D. **Essex and Cereal Diseases.** *Agric. Bull. Essex W.A.E.C.* 1943, No. 6, p. 7.

743* WESTON, W. A. R. D. **Leaf Spot of Celery.** *Agriculture : J. Minist. Agric.* 1944, **51,** 561–563.

742* WESTON, W. A. R. D. **Leaf Spot of Oats.** *Agriculture : J. Minist. Agric.* 1944, **51,** 512–514.

760* WESTON, W. A. R. D. **Loose Smut of Wheat.** *Agriculture : J. Minist. Agric.* 1945, **52,** 234–236.

WESTON, W. A. R. D. **Seed Disinfection.** *Mon. Sci. News.* 1943. No. 26.

747* WESTON, W. A. R. D. **Silver Leaf Disease.** *Agriculture : J. Minist. Agric.* 1945, **52,** 176–178.

736* WESTON, W. A. R. D. **Take-All or Whiteheads of Wheat and Barley.** *Agriculture : J. Minist. Agric.* 1944, **51,** 226–227.

PLANT PHYSIOLOGY

BELL, G. D. H. & BAUER, A. B.

Experiments on Growing Sugar Beet Under Continuous Illumination. III. The Production of a Seed Crop in the Field and the Resolution of Heterogeneous Population.

J. Agric. Sci. 1943, **33,** 85–94.

Sugar beet of the Hilleshög strain sown in November in boxes and grown in an unheated glasshouse until March produces plants which will rapidly bolt after transplanting into the field. Between 97 and 99 per cent. of these plants may produce ripe seed. With later sowings increased proportions of seeding plants are dependent on growing the young plants under continuous illumination in the glasshouse, and by suitably adjusting the length of the growing season and the length of the light treatment, a physiological resolution of the population in relation to the propensity to bolt can be obtained.

Plants grown in a warm glasshouse under continuous illumination can be made to flower and set seed considerably earlier than those grown under cool conditions and transplanted into the field.

Morphological study of the light-treated material grown in the field showed that the seeding habit varied considerably, and that this habit was correlated with the time of anthesis and the type of root. In addition the weight of clusters per plant and the proportion of large, medium and small clusters is also correlated with the time of anthesis and the seeding habit and root type.

The great range of morphological and physiological types which may compass one commercial strain of sugar beet is a matter of great significance in relation to selection for improved types of sugar beet based on characters other than those of the commercial root.

DRIVER, C. M. & HAWKES, J. G.

Photoperiodism in the Potato.

Imp. Bur. Plant Breed. Genet. Pp. 36. Cambridge, 1943. Price 2*s.* 6*d.*

Part I of this bulletin deals with effect of the duration of the light period upon the growth and development of the potato plant. A selection gives the experimental methods of a number of investigators since Garner and Allard's experiments in 1920, and later sections discuss the effect of long or short daylight periods upon vegetative growth, flowering and seed production, stolon and tuber formation and maturity. Evidence is presented of the inheritance of the photoperiodic reaction and its physiological nature is discussed. A section deals with the modifying action of temperature upon the photoperiodic response, and another summarizes the reaction of the South American species and varieties.

Part II deals with the reaction to long and short days at Cambridge of a number of lines from the Empire Potato Collection. Some 75 clones from 8 species were tested and assessed on tuber weight, tuber number, stolon production, time of maturity, height of plants and flowering.

710* HAWKES, J. G.

Some Effects of the Drug Colchicine on Cell Division.

J. Genet. 1942, **44,** 11–22.

Treatment of *Allium Cepa* seedlings by colchicine was found to be most effective for producing chromosome doubling in concentrations of *M*/1000 (0·04%) to *M*/100 (0·4%). During mitosis the spindle mechanism is inhibited but can recover its normal function after mild treatment. The only cytological effect of the drug is apparently on those stages where the spindle would normally be present. Contrary to Levan's statements the centromere of the *c*-pairs rarely divides until the resting stage has been entered. At the end of the *c*-metaphase the chromosomes are reformed into a lobed restitution nucleus very distinct in form from the ordinary resting nucleus. Hence the number of restitution nuclei in a root gives a direct indication of how many cells have divided whilst under the influence of the drug. Those cells which have passed through more than one division under colchicine influence are incapable of many further divisions, since the resulting plants never possess more than double the normal number of chromosomes.

The division cycle is greatly lengthened to about 33 hr., the longest phases being the blocked *c*-metaphase and early restitution phase. This time is about twice as long as normal divisions under similar conditions.

The subterminal root swellings are shown to be due not, as Levan supposed, to an increase in cell volume consequent on a greatly increased chromosome complement but to a lack of polarity in the diploid cells behind the root tip. Instead of growing longitudinally, the maturing cells do so in all directions, their volumes remaining roughly the same as those of the cells in untreated roots.

It is also shown that a similar effect of subterminal root swelling is produced by heteroauxin treatment and that neither colchicine nor heteroauxin can produce any subterminal swellings if the root tips are removed.

SOILS AND MANURES

CHILDS, E. C.

A Note on Electrical Methods of Determining Soil Moisture.

Soil Sci. 1943, **55**, 219–223.

Attention is drawn to the serious effects of contact resistance on the capacitance of soil condensers, which are sufficient to throw doubt on soil moistures measured by this means.

720* CHILDS, E. C.

Studies in Mole Draining : Interim Report on an Experimental Drainage Field.

J. Agric. Sci. 1943, **33**, 136–146.

The layout and recording equipment of the first experimental drainage field in this country are described. The experiment is sited on grassland with slight ridge and furrow, and information has already been obtained as to the edge effects of individual plots, the nature of our typical rainfall and the response of mole drains to rainfall fluctuations of even a minor character, modification of drain performance with increasing age and state of decay, and the rate of absorption of water in the soil during a drainage performance.

CHILDS, E. C.

The Water-Table, Equipotentials and Streamlines in Drained Land. I.

Soil Sci. 1943, **56**, 317–330.

A method of electric analogues is developed for tracing the water-table in light land overlying an impermeable stratum, (assuming steady rainfall) for drains of various diameters, rainfall rates of various intensities and soils of various depths. No support is provided for the elliptical water-table deduced by the well-known risky application of the Dupuit-Forchheimer theory.

CHILDS, E. C.

The Water-Table, Equipotentials and Streamlines in Drained Land. II.

Soil Sci. 1945, **59**, 313–327.

Continuing the electric analogue studies, it is shown that measurements of water-table depth in the field by means of bore-holes may be inaccurate owing to the perturbation of the flow net caused by the bore-hole itself. The relative efficacy of empty and flooded drains and of open ditches versus piped and filled trenches is discussed. A method is developed for taking the capillary fringe into account, and it is shown that this may be ignored without causing more than a slight error in computing the location of the water-table, although the capillary fringe is itself, of course, of considerable importance. Certain theoretical deductions as to the shape of a water table at its junction with a surface of seepage at an open ditch are made, and the hodographs of both an open ditch and a pipe-drain flow net are developed.

756* CHILDS, E. C.

The Water-Table, Equipotentials and Streamlines in Drained Land. III.

Soil Sci. 1945, **59**, 405–415.

Continuing this line of work, the unsaturated soil above the zone of ground water is discussed. The conditions for vertical flow (usually assumed) are deduced, and it is shown that the maximum departure from verticality likely to occur in practice does not introduce large error in computing the water-table location, and such error as is made is on the safe side, resulting in drain design which is rather better than is strictly necessary.

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CHILDS, E. C. **Some Aspects of the Science of the Soil.** Contribution to *Farming Handbook.* No. 2, pp. 33–49. Jarrold, 1943. Price 5*s*.

HANLEY, F. **Manuring for Arable Crops in War Time.** Contribution to *Farming Handbook.* No. 2, pp. 50–63. Jarrold, 1943. Price 5*s*.

HANLEY, F. **Sowing Seed and Fertilizer Together.** *Agriculture : J. Minist. Agric.* 1944, **50**, 493–496.

786* NICHOLSON, H. H. **The Field Drainage Problem.** *Agric. Progr.* 1943, **18**, 22–27.

787* NICHOLSON, H. H. **Modern Field Drainage.** *J. R. Agric. Soc.* 1943, **104**, 118–135.

STATISTICS

800* Hudson, H. G.
Population Studies with Wheat. II. Propinquity.
J. Agric. Sci. 1941, **31**, 116–137.

An investigation of the problem of propinquity has shown that the yield of any unit of 6 in. of drill row of wheat is significantly affected by the number of plants in adjacent units. The competition " correlation ", which measures the intensity of this effect, is greatest with medium plant densities, and low and often insignificant for units of high or low plant density.

Competition is primarily underground for water, soil nutriments and soil air ; of these, competition for water is most important in determining yield.

The variation of plant number from unit to unit in a field, caused chiefly by irregularities of the seed drill, does not cause undue loss of yield. In three experiments 0·82, 1·79 and 1·06 bushels/acre (representing 2·37, 3·72 and 4·17% of the optimum yield respectively) were lost owing to unevenness of plant.

801* Hudson, H. G.
Population Studies with Wheat. III. Seed Rates in Nursing Trials and Field Plots.
J. Agric. Sci. 1941, **31**, 138–844.

The discrepancies between nursery plots and field plots, found by previous workers when investigating yield problems with wheat, are discussed. The reason for these differences is given, and the true optimum plant density identified.

It is shown that the intensity of competition for water and soil nutriments influences the optimum plant density. and that a high intensity of competition is associated with a low optimum plant density. A summary of literature is given, and the varying values for the optimum seed rates in different parts of the world interpreted in the light of water and soil nutriment supplies.

MISCELLANEOUS

794* Markham, R.
A Steam Distillation Apparatus Suitable for Micro-Kjeldahl Analysis.
Biochem. J. 1942, **36**, 790–791.

A highly efficient steam-jacketed steam distillation apparatus is described.

Details are given of its application to the estimation of quantities of N down to 0·02 mg.

Smith, K. M.
Beyond the Microscope.
Pelican Books, London. 1943. Price 9*d*.

OTHER PAPERS

803* HAMMOND, J. **Nutrition in Jamaica.** *Nature, Lond.* 1945, **156**, 288.

HAMMOND, J. **Problems of Production in Relation to Post-War Nutritional Relief.** *Proc. Nutrit. Soc.* 1944, **2**, 190–194.

HAMMOND, J. **Relief Measures for Agriculture.** Contribution to *When Hostilities Cease.* Pp. 92–98. London, 1943.

HAMMOND, J. **Some Uses of Milk Recording.** *Ann. Rep. Yorks Br. Nat. Milk Rec.* 1943, 13–15.

AUTHOR INDEX

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